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The European Green Building Programme

2010

Evaluation

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Joint Research Centre
Institute for Energy and Transport

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The goal of improving end-use energy efficiency and promoting the use of renewable energy sources is a key component of the EU energy and climate change policies, shared by all EU Member States. The European Commission Directorate general Energy contributes to this goal through a series of actions under the "Intelligent Energy – Europe" Programme. Given the large share of energy consumption in buildings and the large cost effective energy saving potential, special attention has been dedicated to the building sector. To this end a major step forward is represented by the Directive 2002/91/ED on the Energy Performance of Buildings and the Recast of the EPBD 2010/31/EU.

The GreenBuilding Programme (launched in January 2005) is one of these actions, aimed specifically at improving energy efficiency in private and public non-residential buildings.

The GreenBuilding Programme is a European Commission voluntary programme through which non-residential building owners and occupiers, being private or public organization, are aided in improving the energy efficiency and to introduce renewable energy sources into their building stock. Any enterprise, company or organization (hereinafter defined as "organization") planning to contribute to the GreenBuilding programme objectives can participate.

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Executive summary

GreenBuilding is a voluntary programme aiming at improving the energy efficiency of non-residential building in Europe on voluntary basis. The programme addresses owners of non-residential buildings to realize cost-effective measures which enhance the energy efficiency of their buildings in one or more technical services.

The present report summarizes the result of the GreenBuilding Programme achieved in 2010, in terms of main energy efficiency measures in the building and related energy savings. Until December 2010, total 282 Partners have joined it with 469 Partner Buildings. The total savings achieved by the Partners are 432 GWh/year. 128 GWh/year have been saved in 2010. In 2010, 116 new Partners joined the Green Building programme with 183 buildings. The average percentage of savings, for this period, amount to 41,6%, which is well above the GreenBuilding Programme requirements (25%).

In most of the buildings, to achieve the above savings, more than one energy efficiency measure has been implemented. Most often is a combination of three or more measures. The reason for implementing more measure at once are the economic effectiveness, but also design needs. If not done at once, it may leave some of the measures unimplemented as there will not be a sufficient potential for savings or the pay back would result too long. Also, it is clear that it is less effective to change a heating system and only subsequently deal with the building envelope and heating losses.

The economic effectiveness is a prerequisite for joining the GreenBuilding Programme. Therefore, the Partners have rarely reported on the economic features of their projects and all of the projects are supposed (and assumed) to be economically viable.

The GreenBuilding Programme has been successful over its five year operation. The number of Partners is growing on an increasingly growing rate, with a very good result in 2010. Nevertheless, in the future, the programme may need to be more widely promoted among stakeholders. This way the programme can serve as the benchmarking tool and in the same time promote the Partners and their achievements to the general public. Wider publicity of the programme will help to achieve its main goal: promotion of energy efficiency in buildings.

In this report it has been also compared the results of the year 2010 with the results of the previous period of analysis (2005-2009)[1] in order to better understand the trend of growth and development of the programme.

Introduction

In 2005, the European Commission initiated the European GreenBuilding Programme (GBP "Programme"). This programme aims at improving the energy efficiency and expanding the integration of renewable energies in non-residential buildings in Europe on a voluntary basis. The programme encourages owners of non-residential buildings to realize cost-effective measures which enhance the energy efficiency of their buildings in one or more equipment system. The programme is managed by the Joint Research Centre (JRC) of the European Commission. It is operational in all 27 European Union (EU) Member States, European Economic Area (EEA) countries, Switzerland, Norway and accession countries as Croatia and Turkey.

Any owner of non-residential building is it public or private organization can join the GreenBuilding Programme as a GreenBuilding Partner (the Partner). Partner organizations commit to undertaking energy efficiency actions, which they describe in an action plan. If the action plan is accepted by GreenBuilding, the company is granted Partner status. The saving has consequently to be reported. Businesses from the building sector, contributing to energy efficiency in the non-residential building sector with their products or services, can join as GreenBuilding Endorsers. The Endorsers help in promoting GreenBuilding Programme to potential participants and support already registered GreenBuilding partners in their efforts to reduce energy consumption. The Endorsers[2] must have assisted at least one building owner in becoming a GreenBuilding Partner and are expected to submit a promotion plan, in which they specify further activities to promote the GBP.

Next to the main GreenBuilding Programme administration, the Joint Research Centre, the so called National Contact Points (NCP) have been established in the countries participating in the GreenBuilding Programme[3]; the NCPs represent the main intermediary between the JRC and the Partners/Endorsers. They assist the organizations in their efforts to join the GreenBuilding Programme, provide information about the Programme and organize promotional activities.

[1] Bertoldi, P., Valentova, M.: The European GreenBuilding Programme 2006-2009 Evaluation

[2] List of Endorsers can be found in the web site of the project:
http://re.jrc.ec.europa.eu/energyefficiency/greenbuilding/

[3] List of National Contact Points can be found in the website of the project:
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The GreenBuilding Programme provides support to the Partners in the form of information resources and public recognition, such as press coverings in newspapers and magazines, presentation at fairs and conferences across Europe, a regular newsletter, and a brochure and a catalogue of success stories. The GBP plaque allows Partners to show their responsible entrepreneurship to their clients.

1.Objectives

The aim of the current report is to provide a summary analysis of the results of the GreenBuilding Programme (GBP) in 2010.

Also a comparison analysis with the data of the period 2006-2009 will be provided.

Up to the end of 2009, 167 Partners joined the Programme with 286 buildings coming from various fields and sector of operation. In the period 2010, 116 new Partners joined the Programme, with a total of 183 buildings, which is a very good result.

The buildings themselves vary in age, size and use, but they all have in common the energy performance, which goes far beyond the average performance of buildings in the respective sectors in the participating countries.

The present report focuses mainly on the typology of the Partners, on the efficiency measures they have taken (technical equipment, renewable energy sources, etc.) and on the related savings achieved.

2. Methods

Partners who join the GreenBuilding Programme with their buildings include a report to their application, in which they provide information on the level of achieved savings and a description of the efficiency measures through which they achieved the declared savings.

A spreadsheet analysis was made in order to evaluate the results achieved by the Partners.

The buildings are assessed in a database as to their year of construction, year of refurbishment (start and ending) or if they are still under construction.

Another categories used to obtain statistical evaluation on the programme in 2010 was public/private owners of the building submitted.

As there are relatively many type of buildings, the following table (Table 1) shows the main categories, into which the buildings were sorted out, in order to allow the analysis, while capturing the prevalent uses of the buildings.

Table 1 Business categories (prevalent in case of multiple category)

Airport	Airport
Commercial center	Shopping malls but also smaller retails. Commercial center are often comprehensive of restaurants, offices, etc.
Education	From kindergartens to universities, comprehensive also of student accommodation.
Healthcare	Hospital, but also clinics, day care and rehabilitation centers.
Hotel	Hotels, B&B, accommodations.
Industry	Warehouse, storage, production hall, manufacturing buildings, workshops.
Offices	Buildings mainly for office use
Sport and leisure	Swimming pools, sport centers, leisure centers
Others	Church, social housing,, fire station, etc.

The achieved savings are analyzed as to their absolute levels (kWh/year) and in relative terms (% of the consumption before refurbishment for existing building and in comparison to the Reference Value of the country for the new building). Also the energy consumption kWh/m^2/year was taken into account for the final evaluations and results.

The efficiency measures varied to certain extent among partners (given the different use, geographical area or year of construction) nevertheless the measures were categorized into 8 main areas, which were found as the common denominator.

The categories were: Heating, Cooling, Ventilation, Electrical equipment, Envelope (U value), Renewable Energy Sources (RES), Control System and Others.

Within the general category of Heating, the followings principal systems were earmarked: district heating, heat pump, CHP (Combined heat and Power generation) and boilers (condensation type, natural gas, biomass and oil).

All the technical measure will be analyzed in the followings chapters.

It is important to emphasize that not all the information was provided from all Partners. Nevertheless, the missing pieces of information were relatively negligible. Yet, as there are

different format of the reporting form in the participating countries, for many Partners only partial information was provided. In the following analysis this is always acknowledged either including an “n/a” (not available) share or by stating the total population of the sample.

The only section though, where the number of provided sets data is significantly lower is the information on economic characteristics of the projects. No analysis is provided for economical aspects, all of the projects are supposed (and assumed) to be economically viable.

The report is based on information only provided by the Partners. The reporting forms are always being checked by the National Contact Points for inconsistencies, before being sent to the JRC, and then also checked by the JRC, before granting the Building and the organization a GreenBuilding Programme Partnership status. Nevertheless, the analyzed data has to be taken keeping this limitation in mind.

From 2011 a common template Excel sheet for reporting by Partners was introduced. This will permit to have harmonized data and more accurate analysis.

3 Results – the GreenBuilding Programme

3.1 General description of the partner buildings

There is a difference between the number of Partners, who joined the GreenBuilding programme and the number of Partners Buildings, which have received the GreenBuilding Certificate. The GBP Certificate is always granted to a specific building. Therefore one GBP Partner can join the programme with more buildings. Each of these buildings is assessed separately and receives the certificate on an individual basis.

From 2006 to 2009 the total number of Partners amounted to 167 and the total number of GreenBuilding certified building was 286.

In the year 2010, 116 Partners joined the programme with a 183 Building.

The total number of Partners that joined the Programme, from the star up until December 2010, amounts to 283 with a total number of 469 Building.

The positive constant growing trend is a good feedback on the growing interest for the programme.

From the beginning of the programme, it had Partners coming from 18 countries[4], from which 14 are part of the EU. Geographically, both southern and northern countries are represented.

In 2010 the highest number of GBP Partners come from Germany (58), followed by Sweden (24). Austria has 7 and Spain 6.

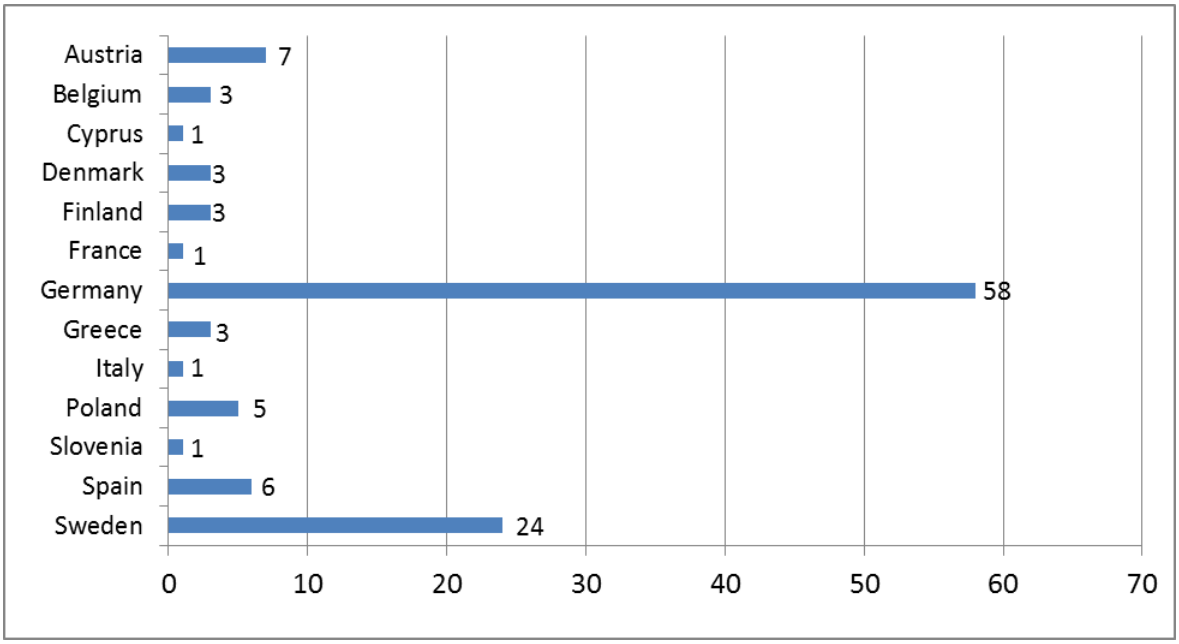
Cyprus and France are new countries that joined the GBP.

No new Partners joined from Portugal, Hungary, Norway, Turkey and United Kingdom.

There have been a few international companies, which have joined the GBP in different countries such as Skanska, or Siemens. In this case, each Partner is taken into account separately (e.g. Skanska Property Poland and Skanska Commercial Development Nordic Denmark are considered as two Partners).

[4] Austria, Belgium, Croatia, Cyprus, Denmark, Finland, Germany, Greece, Hungary, Italy, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Turkey, United Kingdom.

Figure 1 Partners per country in 2010



The highest number of Partners have been registered in Germany (58), followed by Sweden with 24 Partners. This trend is similar to the period analyzed in the previous report (The European GreenBuilding Programme 2006-2009- Evaluation), were Germany was represented with 48 Partners (the highest presence) followed also by Sweden with 36 Partners. In most countries the number of buildings, to large extent, copies the number of the Partners (Figure 2).

Figure 2 Buildings per country in 2010

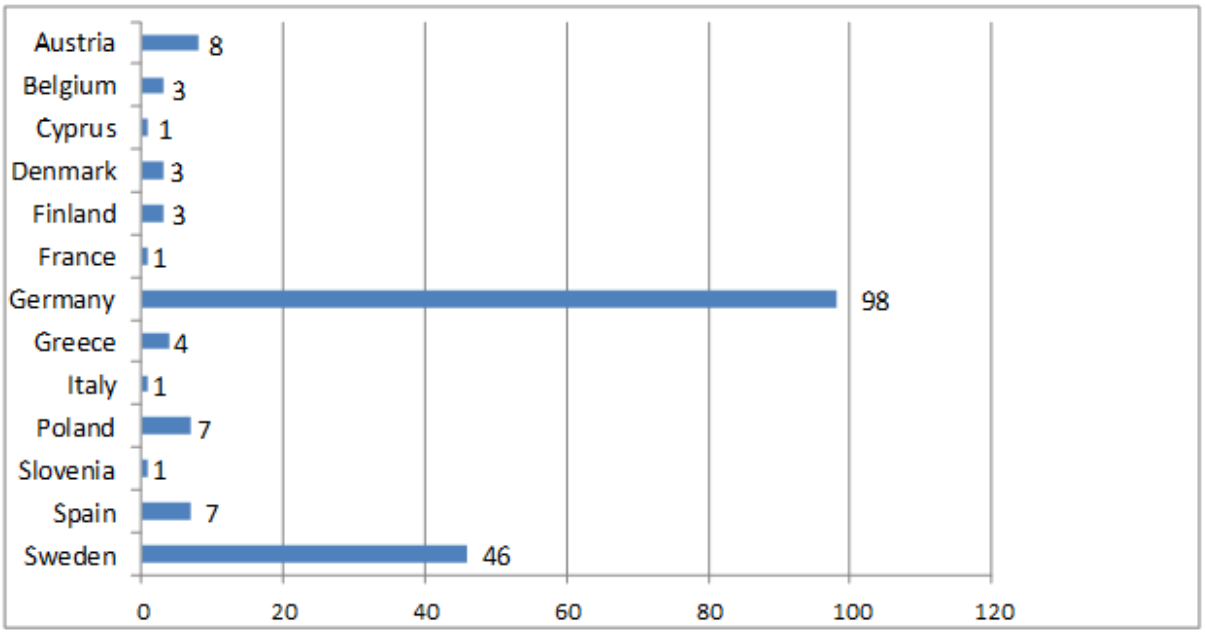
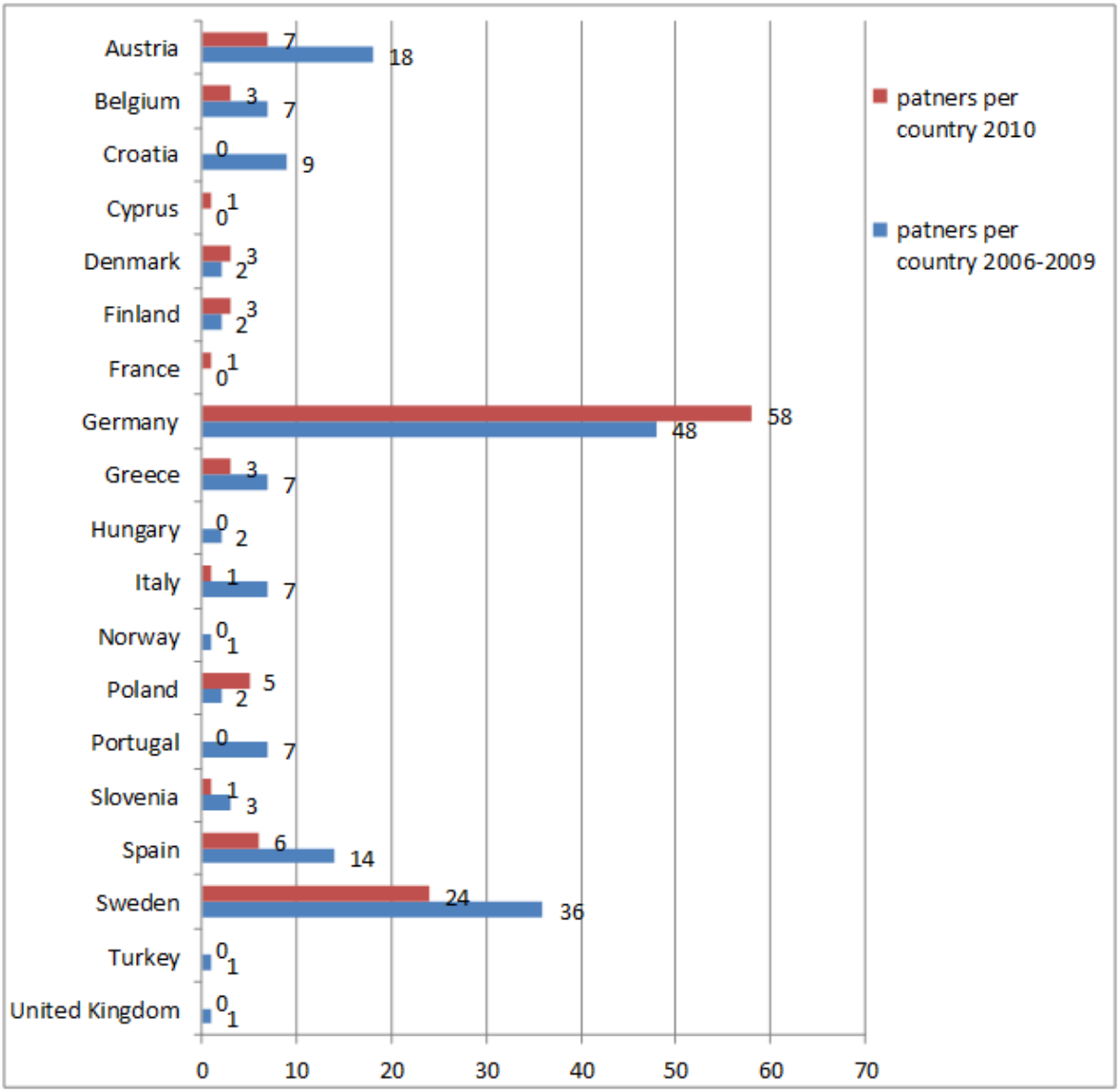


Figure 3 Partners per country – Comparison between the period 2006-2009 and the year 2010



From the graphic above we can see that Germany remains, through all the years of the GB programme, the leading country in terms of number of Partners that joined it. Sweden remains in second position. So is for two countries, Austria and Spain, which follow, in the year 2010, the previous trend of the period 2006/2009. Poland is the only country which increased its number of Partners in comparison with the previous period. In comparison to period 2006/2009 some countries have no Partners joining the programme in 2010, these are: United Kingdom, Turkey, Portugal, Norway, Hungary and Croatia. Italy joined the programme in 2010 with only one Partner and relative building. Two new countries joined the programme with their Partners: Cyprus and France.

Figure 4 Buildings per country – Comparison between the period 2006-2009 and the year 2010

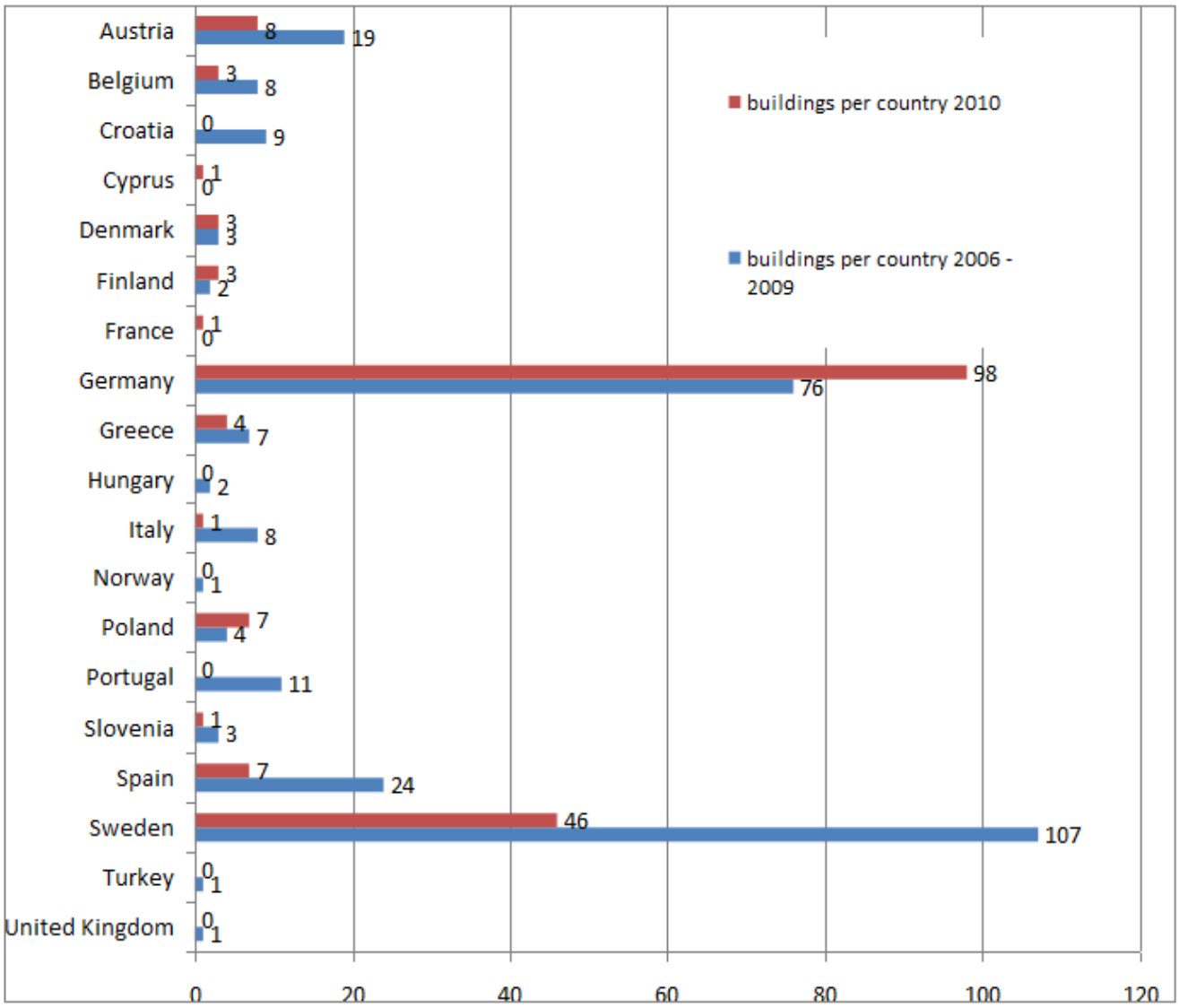
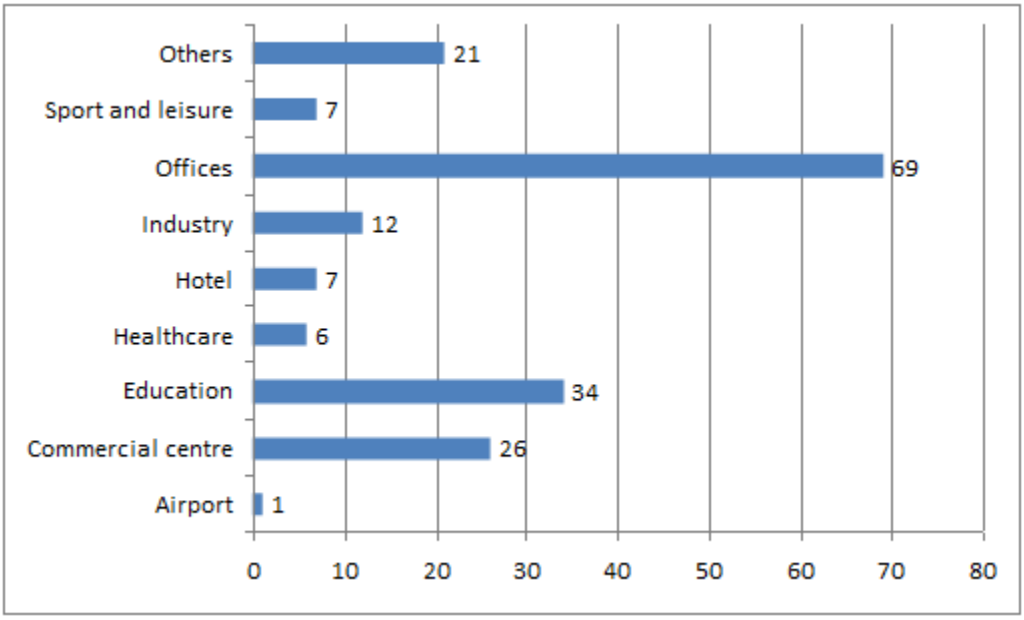


Figure 5 Building's business categories 2010



The majority of the Partners buildings are offices. Other buildings may (and surely do) include offices as well. However, the offices do not represent the main use of the buildings and serve more as background space.

The smallest office registered in the GreenBuilding Programme has an area of 570 m^2 and is new building, the biggest amounts to 250.727 m^2 and is a refurbished building. It is the German building: Westegate Büro-und Geschäftsgebäude.

Offices can be present in the same buildings with shops, or can be part of an industrial building or annexed to a workshop. (e.g Alfred Arnold Verladesysteme Partner has joined with the building "Office and Workshop Building; its prevalent use is for manufacturing activities, for this reason is included in the "Industry" business category)

The second largest group of buildings (although far after the first one) are education buildings. These include kindergartens, primary school, high school and university. The area's range of these buildings goes from 250m^2 (primary school) to 14.999 m^2 (secondary school).

Most of the educational buildings are located in Germany. There are also example of student's residence that have been included in this category also if the end use is accommodation (e.g Residence Hall in Campus Montilivi II, Girona University).

Commercial centers are mostly big shopping mall but also some smaller retails are included in this category. The area's range of these buildings goes from 431 m^2 (TEDI GmbH, Weiler im Allgäu) to 45.701 m^2 (Gerngross City Center Wien in Austria). The majority of the buildings of this category are new buildings (92, 31%). Night draw-down measure to save energy is the most common measures taken in this category. This means that the heating system is equipped with thermostats provided with time-control which can decrease the temperature during the night time, when heat is not necessary.

Sport and leisure included buildings as: museum and art gallery, aquatic center, tourist fortress, sports centers.

Among the category "other" we can find type of as: refugee centers, church, logistic hall and fire station.

This analysis found big similarity with the ones of the previous period time of analysis (2005-2009) where the two biggest business categories were also offices (60%) and educational buildings (8.8%).

No public administration buildings joined the GBP in 2010, in the period 2006-2009 there have been 9 of them. This must not be confused with Public buildings; administrations buildings are building were the end use is for public functions as municipal halls, courts, penitentiaries.

Table 2 Business category in percentage for partners in 2010

Business categories (prevalent in case of multiple category)	Nr. of buildings	%
Airport	1	0,5%
Commercial centre	26	14,2%
Education	34	18,6%
Healthcare	6	3,3%
Hotel	7	3,8%
Industry	12	6,6%
Offices	69	37,7%
Sport and leisure	7	3,8%
Others	21	11,5%
Total	183	100,0%

Table 3 Private and Public organizations per business category

Business categories	n/a	Private	Public	Total
Airport	1			1
Commercial centre		26		26
Education	10	10	14	34
Healthcare	1	2	3	6
Hotel		7		7
Industry		11	1	12
Offices	3	63	3	69
Sport and leisure		2	5	7
Others		14	7	21
Total	15	135	33	183

Majority of the Partner buildings belong to private organizations with 73, 8%; only 18,0% of the partners 2010 are public organizations. This data takes into account that for 15 buildings no information was available.

Table 4 Private and Public organizations per years and percentage

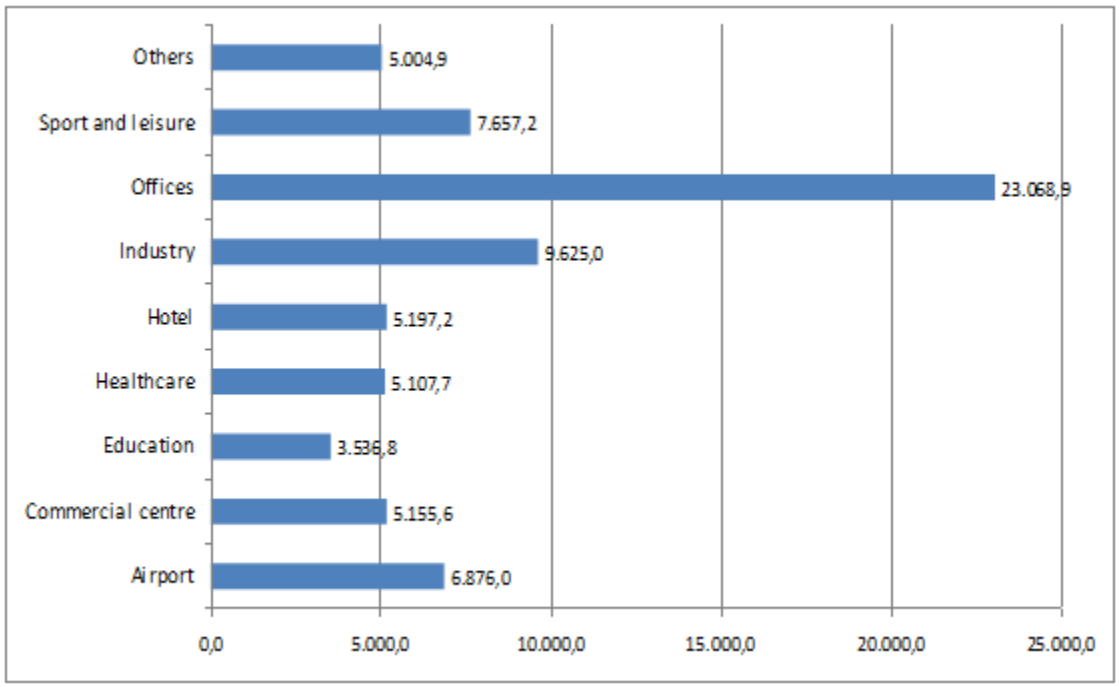
Type of organisations	2010		2006-9		Total	
n/a	15	**8,2%**	0		15	**3,5%**
Private	135	**73,8%**	220	**76,9%**	355	**77,0%**
Public	33	**18,0%**	66	**23,1%**	99	**19,4%**
Total	**183**		**286**		**469**	

Commercial centers, hotels, industries and buildings for the categories “Sport and leisure” and “Others”, only belong to private organizations.

The majority of the buildings belonging to public organizations are educational buildings.

The comparison of these 2010 categories and the one of the previous period analyzed (2006-2009) follows a similar trend in percentage.

Figure 6 Average Area of buildings per building use 2010



No information was available on the area for 32 buildings (17,5%).The business category which has the biggest average area per building is “Offices”.

The smallest of the building’s sample has an area of 250 m^2 and is a school building. The largest building of the GreenBuilding programme has an area of 250.000 m^2 and is an offices building: Westegate Büro-und Geschäftgebäude, which is located in Germany. 28 buildings have an area of less than 1000 m^2 (15%).

The average area of building, for 2010 GB Programme, amounts to 15.906 m^2 (151 buildings have given the information about the area of the building), which is very similar to the average area of the previous period analyzed (2006-2009) which amounted to 15.595 m^2 despite the relevant different number of building of the sample (286 vs. 116).

However, the median of the sample is much lower of the average – about 3.999 m^2- meaning that 50% of the buildings are actually smaller then 4.000 m^2.

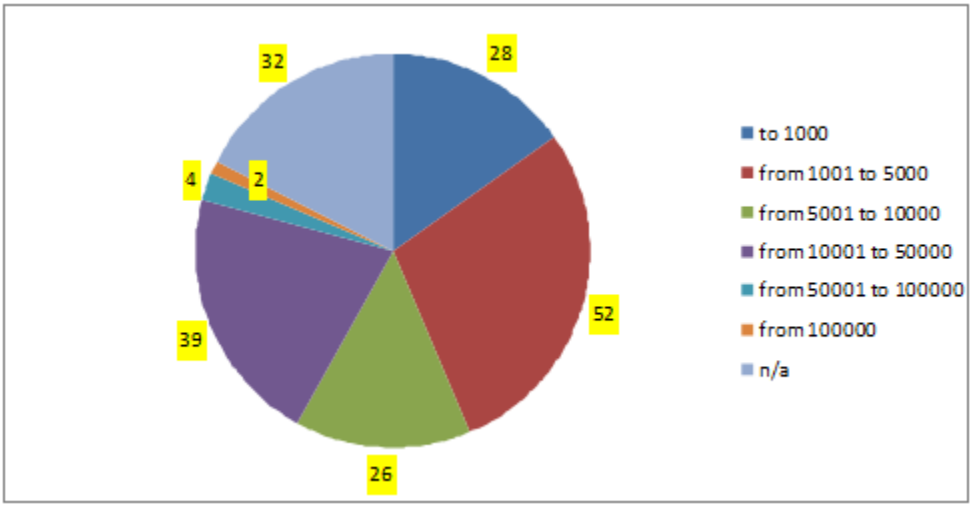
The buildings which have an area range between 50.000 m^2 and 250.000 m^2 are only 7 (3,8%). and are all Offices buildings.

Table 5 Number of buildings for range of area

Area Range in m^2	Nr.of buildings
to 1.000	28
from 1.001 to 5.000	52
from 5.001 to 10.000	26
from 10.001 to 50.000	39
from 50.001 to 100.000	4
from 100.000	2
n/a	32
Total	183

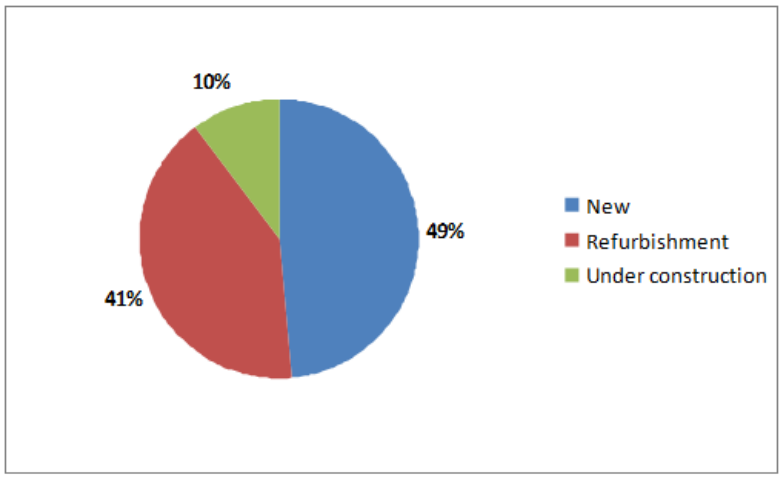
The most of the buildings have an area in the range between 1.001 and 5.000 m^2. Only few have an area larger than 100.000 m^2. The dimensional information about buildings is specified for heated area, cooled area and lighted area. When these values are different, the analysis takes into account the largest one, where the most quantity of energy is consumed. Also information about climate and site are often specified (climate zone, altitude, latitude, heating and cooling Degrees Days).

Figure 7 Number of building for range of area



The buildings also differ in height. On average, as in the previous analysis 2006-2009, the buildings have six above ground floors. However, the differences are big. Among the GB buildings, there are ground floor buildings but also skyscrapers with 40 + floors.

Figure 8 New, refurbished or under-construction buildings

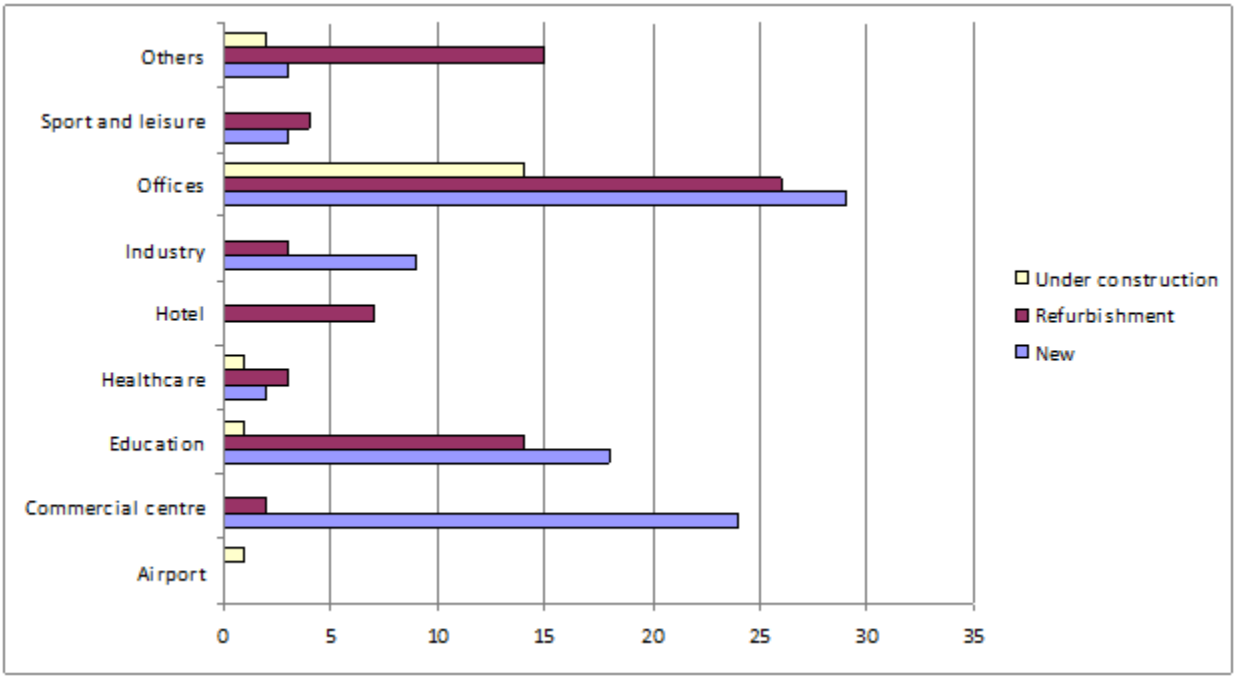


Three types of projects are reported under the GreenBuilding Programme for the period 2010: New, Refurbished and Under construction. In the case of new building the primary consumption achieved must be 25% below the relevant building standard in force (legal reference value) or compared to "conventional" new building, if there is no building code available. In the case of refurbishment the energy consumption before and after the intervention is decisive (again at least 25% of improvement is required). Including the Under construction building in the category New building, it is possible to see that the sample of the buildings are almost split in two similar % values: 51% new and 49% refurbished.

Table 6 New, refurbished or under construction

New or refurbished or under construction	**Number of buildings**
New	89
Refurbishment	75
Under construction	19
Total	183

Figure 9 New, refurbished and under construction buildings per business category

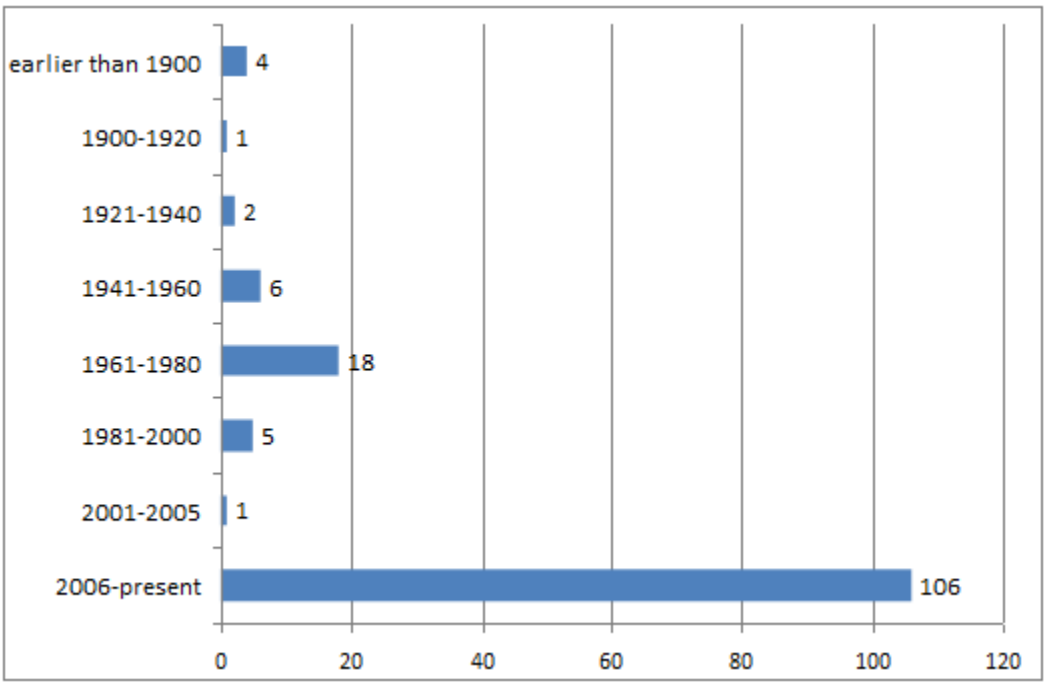


The Figure above shows the distribution, in 2010, of business category for new, refurbished or under construction building.

"Offices" is the main category in all the three sectors. "New-offices" building is the largest category inside “Offices” category itself and also among all the other type of category. Also in the business category “Commercial centre” the new buildings represent the largest part of it. On the contrary the “Hotel” category has only refurbished buildings.

In the category “Other”, the new buildings are: Logistic hall and centers and repair garage; the refurbished ones are: refugees' centers, library and churches.

Figure 10 Year of construction of the buildings



No information was available on the year of construction of the buildings for 40 of them (21.86%). The sample is of 143 buildings.

The year of construction indicate the starting year of construction of a new building, or the year of construction of an existing building that have been refurbished.

The majority of the buildings have been constructed after 2006. Most of the existing buildings have been constructed between 1961-1968. In this period of time very little attention was given to energy measures for saving energy because of the low cost of it, in most of the European countries. For this reason a very high percentage of refurbishment concerns the buildings of those years. It must be noted that the table shows the years of original construction, or the start of it. In many cases the buildings were reconstructed or refurbished several times, or in other cases some part of the building were added later. This was however disregarded in the present analysis, as the original year of construction seems the most relevant in terms of energy performance and for the options of efficiency measures.

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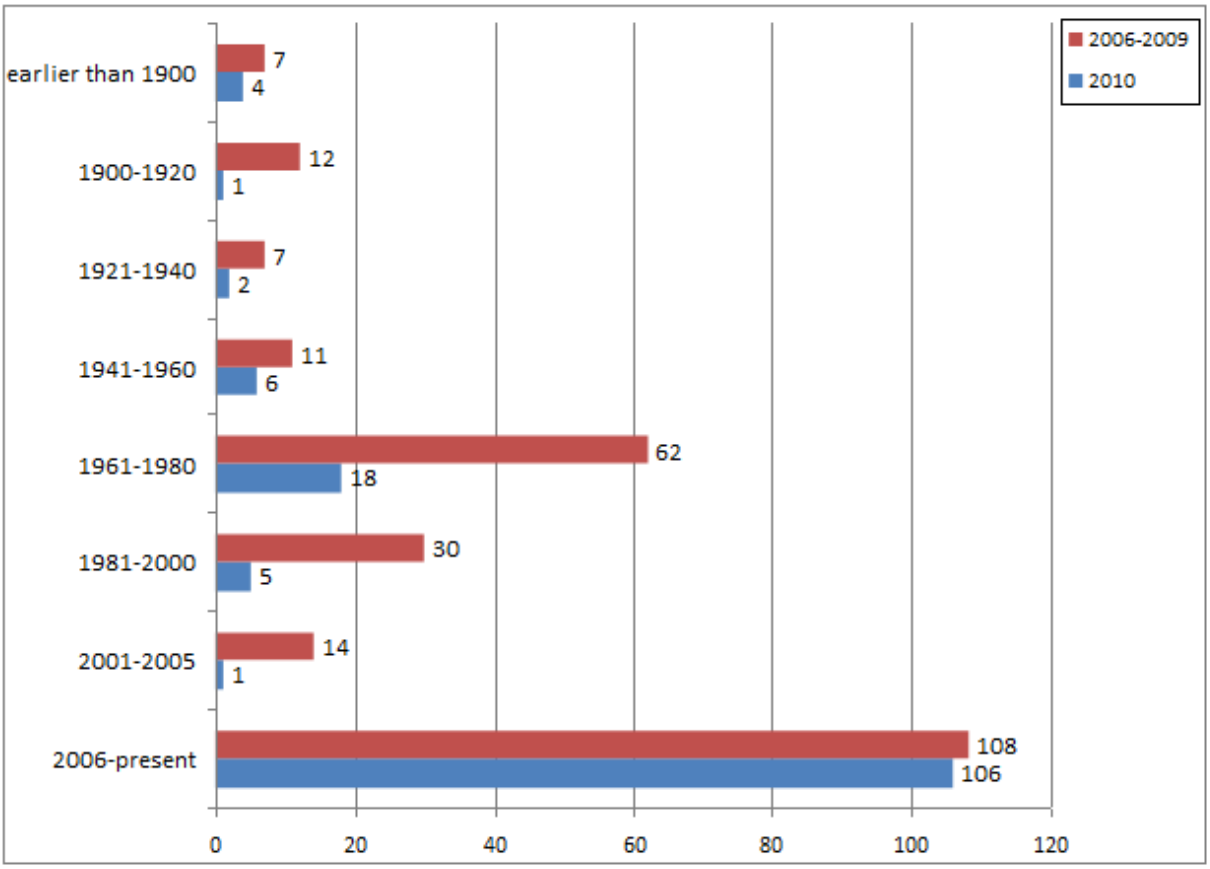
Figure 11 Year of construction of the building – Comparison between the period 2006-2009 and the year 2010.



The oldest building of the GreenBuilding programme was constructed in 1200. 4 building were constructed before 1900.

The graph above shows that the period of construction of the building that goes from 2006 to present is very similar between the two periods analyzed.

3.2 Achieved Savings

The GreenBuilding Partners usually report their savings in two ways: either as absolute yearly savings or as KWh per m^2 and per year. In some case, both sets of data are reported. In case of relative savings (%) it is not important which method or reporting is used. However, if we are to analyze the absolute savings, in case of latter method (reporting KWh/m^2, year), recalculation is necessary.

3.2.1 Absolute savings

Total primary energy savings of the GreenBuilding Programme for 2010 amounted to about 128 GWh/ year. Summed to the saving of the previous period time analyzed (304 GWh/year), the total savings of the GreenBuilding programme so far (until the end of 2010) amounts to 432 GWh).

Table 7 Total saving and percentage per country (KWh/year)

Countries	**Absolute savings in KWh/year**	%
Austria	1.713.738,9	**1,3%**
Belgium	72.450,0	**0,1%**
Denmark	2.683.394,0	**2,1%**
Finland	986.925,0	**0,8%**
France	451.645,2	**0,4%**
Germany	94.621.354,4	**73,8%**
Greece	575.653,9	**0,4%**
Italy	51.040,3	**0,0%**
Poland	11.507.076,5	**9,0%**
Spain	4.195.880,7	**3,3%**
Sweden	11.417.875,0	**8,9%**
Total	**128.277.034,0**	100,0%

The table above depicts the total saving (kWh/year) per country. Maximum absolute saving were achieved in Germany with about 95 GWh/year (73,8%). Poland and Sweden follows with respectively 11.5 GWh/year and 11.4 GWh/year.

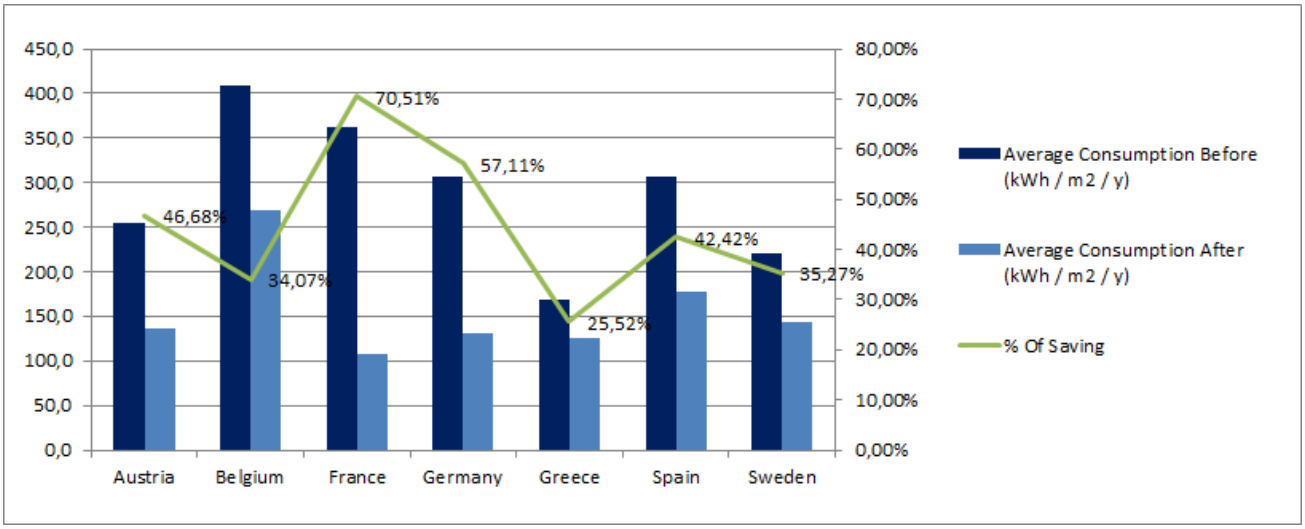
Table 8 Building per country which gave the data for absolute energy savings

Austria	3
Belgium	1
Denmark	3
Finland	1
France	1
Germany	94
Greece	4
Italy	1
Poland	7
Spain	7
Sweden	37
Total	159

In order to have a correct analysis of the absolute savings per country is necessary to enlighten the number of buildings for which we have the absolute savings data. Belgium, Finland and Italy just gave the data for a single building each. The table above shows the huge difference, in number of buildings, between Germany and Sweden compared to other countries. This will be considered also in the analysis of relative savings per country.

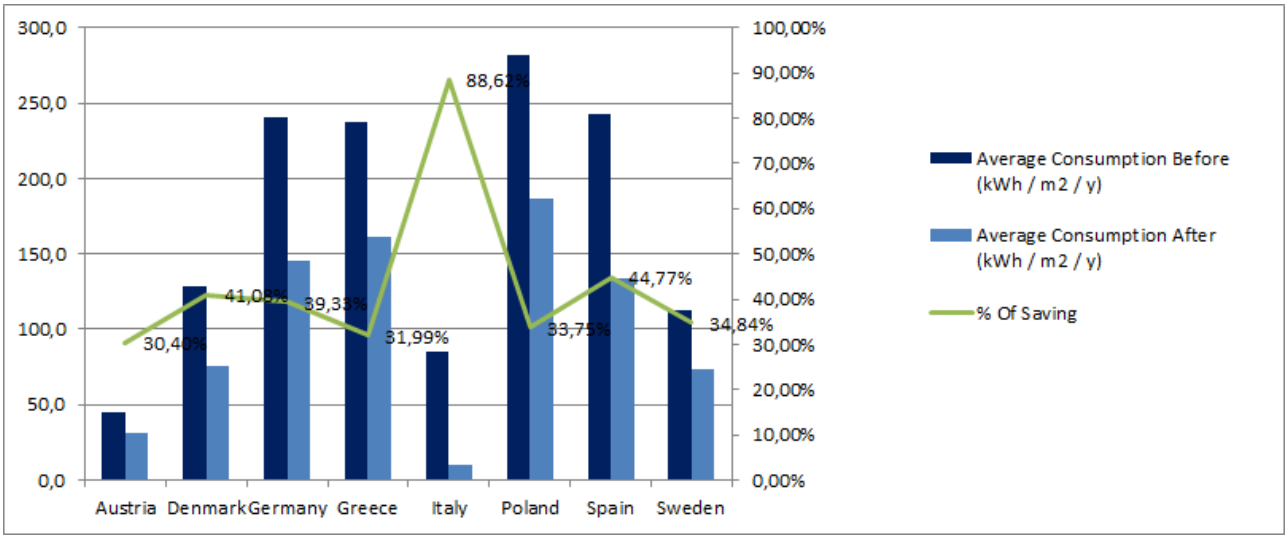
The savings are mostly underestimated to some extent. There are two reasons for this. Firstly, the reported savings have often been only estimates (e.g. for new and under construction buildings), secondly there are 45 GBP partner building for which no data on absolute energy savings were available (ca 24,5 % of the buildings).

Figure 12 Average consumption before and after for refurbished buildings per countries



The figure above shows that the best average saving for refurbished building has been achieved in France (70,51%). The Figure below shows that the best achieved saving for new building has been reached in Italy (88,61%), but also the only building which joined the GB Programme, for this country, in 2010.

Figure 13 Average consumption before (legal value) and after for new buildings per country



The table below shows the absolute savings for the categories new/refurbished/under construction. Over 183 buildings, the analysis was made on 138 buildings that reported this value. In some case the Partner reports the consumption before and after in kWh/m^2/year, but they do not give the total area of the building; in these cases was not possible to calculate the absolute saving of it.

Table 9 Absolute Savings for new, refurbished and under-construction buildings

New or refurbished or under construction	Absolute savings in KWh/year	Nr. of buildings
New	31.920.741,8	74
Refurbished	67.324.895,7	48
Under construction	29.031.396,4	16
Total	**128.277.034,0**	**138**

Total primary energy savings for the GreenBuilding Programme in 2010 amounted to about 128 GWh/year. Compared to the total savings of the period 2006-2009, which was of 304 GWh/year, it is possible to say that the result achieved in 2010 is a very relevant one.

The absolute savings are underestimated to some extent. These for two reasons: firstly, the reported savings have been only estimated (e.g. for new buildings and for under construction buildings), secondly because there are 45 Partners for which no data on this value were available.

The largest absolute saving is achieved in the category “Refurbished”. But if we sum the values of the New buildings with the ones of the Under Construction ones (which can be considered also new buildings) we can see that a certain balance in achieved.

Table 10 Absolute savings and Average savings per business categories

Business Cat	Absolute saving in kwh/year	Nr. Of Buildings	Total Bld. Area m²	Average saving per bld. in KWh/year	Average saving per bld. in KWh/ m²/year
Hotel	4.494.338,9	6	31.183,0	749.056,5	144,1
Others	4.814.319,1	9	39.048,5	534.924,3	123,3
Education	9.832.102,6	28	103.649,0	351.146,5	94,9
Sport and leisure	3.979.915,9	6	45.943,0	663.319,3	86,6
Industry	8.818.974,2	12	115.500,4	734.914,5	76,4
Offices	91.973.459,2	53	1.213.785,6	1.735.348,3	75,8
Healthcare	116.124,5	2	1.923,0	58.062,3	60,4
Commercial centre	4.247.799,5	22	103.101,6	193.081,8	41,2
Total	**128.277.034,0**	**138**	**1.654.134,1**	**929.543,7**	**77,5**

The table above shows the absolute saving, the average saving per business categories and the average saving for business category per kWh/m^2/year. For the airport category only one building has joined the GB Programme, but no data was available to calculate its absolute saving value. Apart from this building use, the highest average absolute savings per Partner building are reported in the "Offices" category (91.973 MWh/year) also because of the largest number of building in this category followed, far behind, by Education buildings (9.832 MWh/year) and Industry (8.818 MWh/year). Hotel is the category who performed the best average saving per m^2, which is the most important indicator of efficiency . The average saving in Kwh/m2/year is 77,5.

Table 11 Average saving per building and per m2 for different ranges of area

Range area m2	Nr. Of Bld	Total area per range	Absolute saving in kwh/year	Average saving per KWh/year/m2	Average saving per bld in KWh/year
to 1.000	28	16.621,1	1822382,9	109,6	65.085,1
from 1.001 to 5.000	52	121.952,8	15988759,7	131,1	333.099,1
from 5.001 to 10.000	26	198.301,0	15487440,7	78,1	645.310,0
from 10.001 to 50.000	39	805.967,6	46513082,2	57,7	1.453.533,8
from 50.001 to 100.000	4	289.627,5	19740480	68,2	4.935.120,0
from 100.000	2	396.727,0	28724888,2	72,4	14.362.444,1

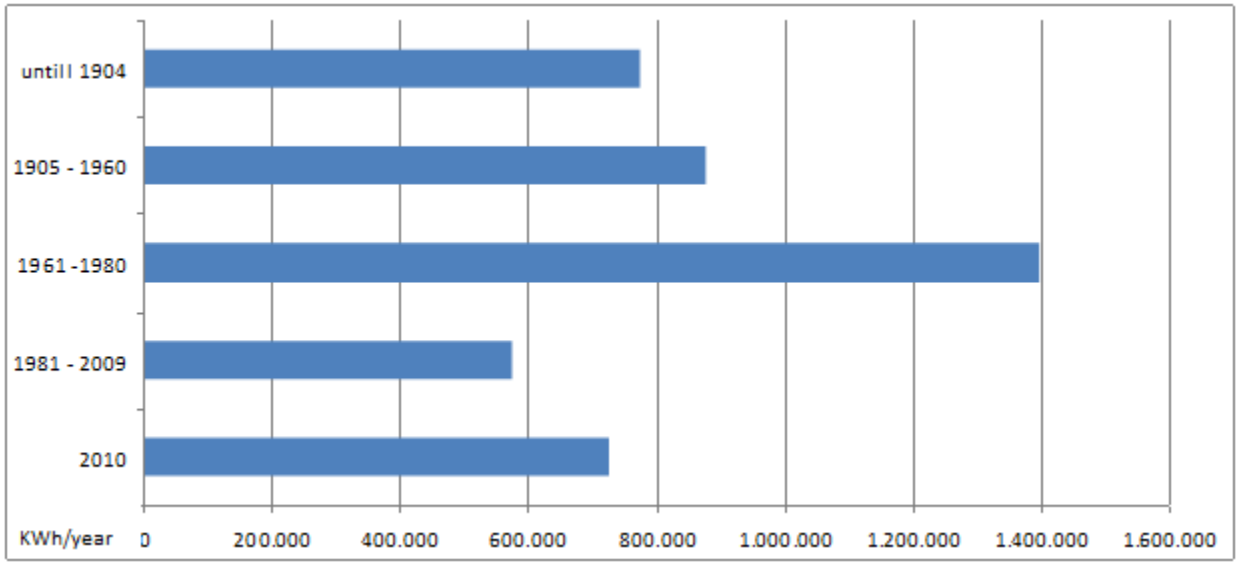
32 buildings on 183, do not have reported the data of the area and of the absolute saving.

The best average savings per m^2 are achieved in smaller building with an area between 250 m^2 (the smallest) and 5.000 m^2. From this area on, to the largest one, the value remains similar.

The best absolute saving has been achieved by Westegate Büro-und Geschäftgebäude with 19.205.688 kWh/year, which is also the largest building joining the GB Programme, but in percentage it saved only 31,5%.

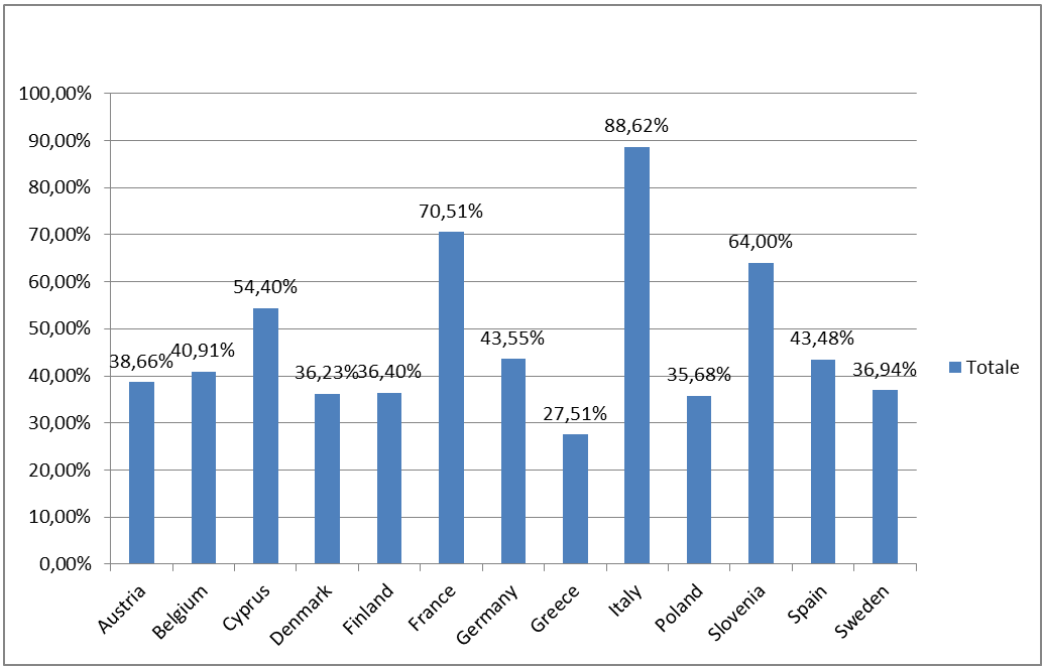
The best percentage saving has been achieve by the kindergarten “Polo Territoriale per la Prima Infanzia di Cologno Monzese” with 88,6%. This is a small building of 673 m^2, with an absolute saving of 51.040 kWh/year.

Figure 14 Total Savings according to years of construction



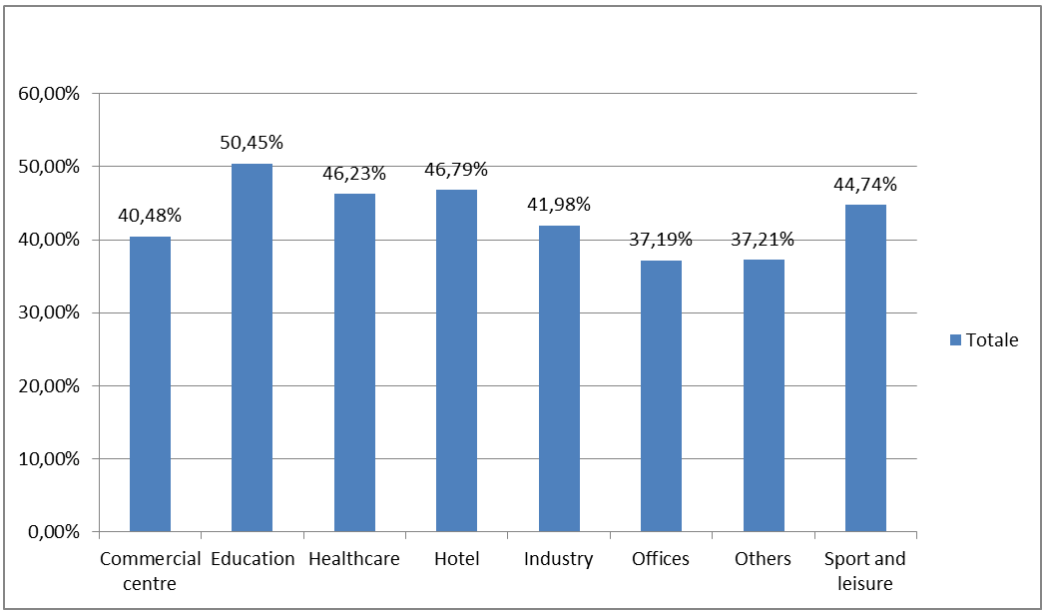
3.2.2 Relative savings and trends

Figure 15 Percentage savings per country



The Figure above shows the percentage savings per country. The average percentage savings range from 88,62% (Italy) to 27,51% (Greece). For 6 Partners buildings no clear information on % savings has been provided, or it could not be calculated from the reported savings. From the total of the 176 Partners buildings, who reported the percentage saving, 132 achieved more than 50%. Six buildings achieved more than 80%. The average savings amount to 41,6%, the median is 35,85%. The data must be evaluated keeping in mind the large disparity of number of buildings per country. Italy, that has the best result in percentage for saving has just one building participating at the GB Programme. Also Cyprus, France and Slovenia has only one while Belgium, Denmark, Finland has three building. Germany and Sweden with their larger participation gave a more reliable sample. For climatically reason all this countries have adopted different kinds of technologies and strategies in order to perform energy efficient buildings. In comparison with the previous period analyzed (2006-2009) Sweden upgrade its performance, growing from 34% to 36,94%, while Germany had a little downturn from 48% to 43,55%.

Figure 16 Percentage saving per business category



The Figure above shows the percentage savings per business category. The average percentage saving range from 50,45% to 37,19%. "Education" is the business category were the best energy saving's result in percentage was achieved (50,45%). This category is comprehensive of different type of educational buildings, from kindergartens to university and also student accommodation. The area range goes from little building (250m^2 to 14.900m^2). 34 buildings belong to this category. 5 of this buildings saved more than 80% of energy. Most of them are located in Germany (22) and Sweden (7).

Offices, despite its large presence in number of building and largest absolute savings, achieved 37,19%. The best energy saving in percentage of this category amount to 75,1 and belongs to a new building located in Germany.

A very good result (46,79%) has been also achieved in the Hotel category, which has only 7 Partners building, all refurbished, with a range of area that goes from 2.569 m^2 to 8.896 m^2. This category achieved also the best result in average saving per kWh/m^2/year.

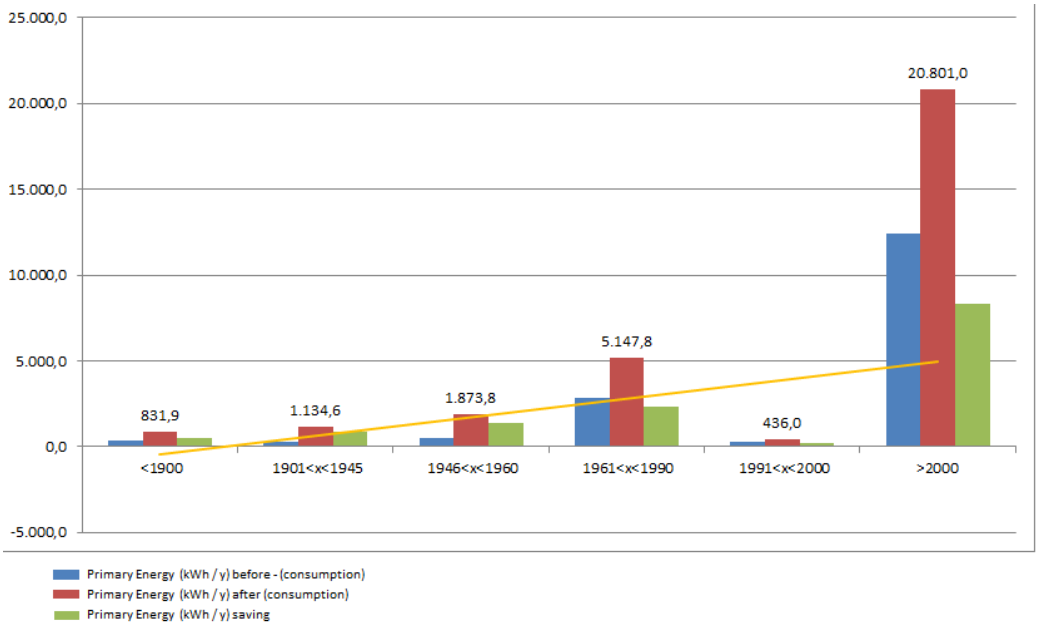
In the "Others" category a very good result (82,5%) has been achieved in a Community Centre located in Germany (Konigstein im Taunus).

Table 12 Consumption before, after and saving for year group

Year Group	Energy consumption before(kWh/ m2 / y)	Energy consumption after (kWh / m2 / y)	Energy Saving %
<1900	831,9	342,2	58,87%
1901<x<1945	1.134,60	305,68	73,06%
1946<x<1960	1.873,80	524,1	72,03%
1961<x<1990	5.147,82	2.801,83	45,57%
1991<x<2000	436	259	40,60%
>2000	20.801,00	12.442,28	40,18%
Total	**30.225,12**	**16.675,09**	**44,83%**

The table above shows the total consumption (in kWh/m2/year) for different year groups. The energy saving % shows that the effective saving has been achieved in building constructed between 1901 and 1945, where refurbishment intervention have been carried out. It is followed by the year group 1946-1960, whit less then 1 point percentage lower. The growing saving trend is shown in the figure below.

Figure 17 Trends over Range Of Year



3.2.3 Office Category

Office Category is treated apart in this chapter; most of the buildings which joined the GreenBuilding Programme are offices and for this reason they have a special importance in this analysis.

This analysis takes into account only the buildings that have this use as prevalent use, but many other buildings of different categories as industry, or hotel have also, as part of their surface, office's areas. These are not taken into account in this particular analysis.

Table 13 Absolute saving and percentage saving per office category (New, Refurbished, under construction)

New or refurbished or under construction	Nr. of Buildings	Absolute saving in kWh/year	Saving in %
New	23	19.429.267,56	34,7%
Refurbished	18	44.064.754,80	39,6%
Under construction	12	28.479.436,80	43,2%
Total	53	91.973.459,16	38,4%

The largest part of the office's building are new ones, considering that the ones that were under construction during the time of the joining are also new, we can say that 77,9 % of these building are new one.

Table 14 Average Consumption (before, after and saving) in kWh/m2/year

Year Group	Valori Primary Energy (kWh / m2 / y) before	Primary Energy (kWh / m2 / y) after	Saving %
New	**217,6**	**130,4**	**59,92%**
to 10000 m2	228,6	138,0	60,38%
from 10001 to 20000 m2	195,9	105,4	53,80%
from 20001 m2	152,8	102,3	66,97%
Refurbishment	**275,4**	**137,2**	**49,80%**
to 10000 m2	299,2	135,2	45,19%
from 10001 to 20000 m2	160,5	104,0	64,81%
from 20001 m2	274,8	181,3	65,98%
Under construction	**276,4**	**168,4**	**60,94%**
to 10000 m2	295,6	176,5	59,69%
from 10001 to 20000 m2	303,5	190,4	62,73%
from 20001 m2	186,2	113,0	60,68%
Totale complessivo	**244,1**	**136,9**	**56,08%**

The table above shows the average consumption in kWh/m^2/year for new, refurbished or under construction Office buildings divided per range of area. No data on the area was available for 32 Partners buildings. The results are quiet harmonised. The range of saving goes from 49,80% to 59,92%. In the category “new buildings” the best percentage saving (66,9%) is achieved in those buildings whit an area larger than 20.001 m^2.The same is for the “refurbished buildings”, were the best result (65,98%) is also achieved in those buildings which have the largest area range.

Table 15 Maximum, Minimum and Average saving for new, refurbished and under construction buildings, per average area.

Area Group	Max absolute saving in kWh/year	Min absolute saving in kWh/year	Average absolute saving in kWh/year
to 10.000 m^2	**1.080.563,2**	**13.737,0**	**427.104,2**
New	1.080.563,2	13.737,0	478.862,9
Refurbished	886.884,6	18.684,3	345.433,1
Under construction	967.788,0	164.411,2	529.781,1
from 10.001 to 20.000 m^2	**2.641.713,2**	**285.380,0**	**1.207.421,7**
New	1.501.185,2	285.380,0	822.576,7
Refurbished	2.203.917,0	572.000,0	1.125.785,7
Under construction	2.641.713,2	719.150,4	1.718.217,2
from 20.001 m^2	**19.205.688,2**	**843.698,3**	**5.776.158,5**
New	3.298.425,7	843.698,3	1.845.263,2
Refurbished	19.205.688,2	6.536.054,0	12.180.733,7
Under construction	9.519.200,0	3.452.129,5	5.923.075,5
Total	**19.205.688,2**	**13.737,0**	**1.768.720,4**

The table above shows the maximum, minimum and average absolute saving (kWh/year), for the three categories: new, refurbished and under construction per range of area.

The best result achieved in the New Office buildings, with an area of less than 10.000 m^2, amounts to 1.080.536 kWh/year. In the area range from 10.001 to 20.000 the best result amounts to 2.641.713 kWh/year. In the largest area's range, from 20.001 to the largest one, the maximum absolute saving amounts to 19.205.688.

As expected, the absolute saving is related to the area, increasing as the area increases.

The average absolute saving for all the offices categories, and among all the area groups, amounts to 1.768.720 kWh/year.

3.2.4 Best Examples of Savings

This section describes the best result achieved both in terms of percentage saving and absolute savings.

Table 16 Best energy saving buildings in percentage

Partner	Building	Saving %	Business category	Area m^2	New/ Refurbished/ Under construction
Comune di Cologno Monzese	Polo Territoriale per la prima infanzia	88,6	Education	673	New
Landratsamt Main-Spessart	Realschule Gemünde	87,0	Education	3.772	Refurbished
Marktgemeinde Rimpar	Matthias-Ehrenfried-Schule Rimpar	86,0	Education	2.384	Refurbished
Konigstein im Taunus	Haus der Bagegnung	82,5	Others	3.515	Refurbished
Grundschulverband Marktbreit	Grund schule Markbreit	81,0	Education	1.922	Refurbished
Marktgemeinde Langenzerdorf	Hauptschule Langenzerdorf	80,1	Education	342	Refurbished
Amt Ortrand	NAW - Grundschulgwbäude	79,6	Education	250	Refurbished
Landschaftsverband Rheinland (LVR)	LVR-Förderschule Louis-Braille	79,0	Education	1.391	Refurbished
Alfred Arnold Verladesysteme	Office and workshop building	78,4	Industry	1.434	Refurbished
Solux GmbH	PHOW- Passive house-office and workshop	75,1	Office	570	New

The table above shows the ten best examples of energy saving in percentage. It is possible to see the strong relation between the best value and the business category "Education". Seven over ten of the best result achieved are in educational buildings. It is also possible to see that this ten best result are mostly achieved in refurbished building. All the building have an area

included between 250 m^2 and 3.772 m^2, which means that in percentage smaller is the area of the building, largest is the result achieved.

The best result has been achieved by the Partner building "Polo Territoriale per la prima infanzia", located in Italy. It is a new building with an area of 673 m^2. The building has function of kindergarten for about sixty children and civic centre for social and cultural activities for families. The building is equipped with a ground water heat pump for heating and sanitary hot water. Free cooling is provided with ground water heat exchanger. Mechanical ventilation is equipped with heat recovery system. The building is also provided with a photovoltaic plant (110 m^2) grid connected.

Table 17 Best energy saving buildings in absolute value

Partner	Building	Saving kWh/yr	% savings	Area m2	New/ Ref/ Under construction
Münchener Rückversicherungsgesellschaft Aktiengesellschaft in Münchener MEAG	Westegate Büro-und Geschäftsgebäude	19.205.688,2	31,5%	250.727	Refurbished
Commerzbank AG	Silvertower	10.800.459,0	39,0%	76.599	Refurbished
European Central Bank	New ECB Premises	9.519.200,0	29,2%	146.000	Under Construction
DVG mbH & Co Objeckt City Haus I KG	Cityhaus 1	6.536.054,0	40,5%	33.691	Refurbished
RheinEnergie AG	Neubau Hauptverwaltung Gebäude 12	4.797.897,0	40,7%	85.830	Under Construction
Aberdeen Property Investors AB	Tobaksmonopolet	3.950.784,0	27,5%	46.208	Refurbished
RheinEnergie AG	Neubau Hauptverwaltung Gebäude 11	3.452.129,5	49,8%	35.047	Under Construction
DEKA Immobilien Invest GmbH	GAP 15	3.298.425,7	26,7%	66.061	New
Echo Investment S.A.	Park Postępu Building C	2.641.713,2	43,2%	15.991	Under Construction

Table 17 shows the ten best examples of energy saving in absolute values. The best result is achieved in an office building, Westegate Büro-und Geschäftsgebäude, located in Germany. This is also the largest building (in m^2) of the GreenBuilding programme 2010. Absolute values are strictly related to the area of the building: the first ten best results have an area included between 250.727 m^2 and 15.991 m^2.The tables shows that very high energy saving in absolute value do not correspond necessarily to high percentage of saving.

The new Partner building with the lowest consumption in Kwh/m^2/year compared to the building code of its country is PHOW - Passive house Office and Workshop, belonging to Solux Partner. Is an office building of 570 m^2 located in Germany. For this building the reference value was 32,1 Kwh/m^2/year, and the building achieved a consumption of 8,0 Kwh/m^2/year with a saving of 24,1 Kwh/m^2/year. The building is equipped with a photovoltaic plant and a geothermal plant. An air-water heat pump is used for the cooling system, the ventilation plant is provided with heat recovery.

The refurbished Partner building with the lowest consumption in Kwh/m^2/year after the restoring intervention is Hauptschule Langenzerdorf, an educational building also located in Austria in Marktgemeinde Langenzerdorf, which is also the name of the Partner. Before the refurbishment the building consumption amounted to 181,9 Kwh/m^2/year, after the consumption decreased to 36,2 Kwh/m^2/year with a percentage of saving of 80%.

4 Energy efficiency measures

The energy efficiency measures are what makes the energy efficiency improvement (or energy savings) possible. From the total of 183 Partner Buildings the measures have been described by 139 of them. (76%)

The measures taken in the period time analysis of this report (2010) have been categorized into 7 main groups:

- Heating system
- Cooling system
- Ventilation system
- Lighting system
- Renewable energy sources
- Control system
- Envelope (walls and windows)

For heating, cooling and ventilation specific subcategories have been made in order to give a better picture of the implemented measure.

The majority of the Partners implemented at least 3 measures. Only 5 buildings implemented 6 measures, the maximum number. For 44 buildings there was no information available on this technical data.

Table 18 Nr of measures implemented in the buildings

Nr. Measures Implemented	Nr. Of Buildings	%
1	20	14,39
2	30	21,58
3	47	33,81
4	16	11,51
5	21	15,11
6	5	3,597
	139	100

Table 19 Measures in buildings, types and %

Types of Measures Implemented	Nr. Of Buildings which implemented the measures	%
Heating system	107	76,9%
Cooling system	68	48,9%
Ventilation system	66	47,4%
Lighting system	61	43,8%
Renewable energy sources	31	22,3%
Control system	52	37,4%
Envelope	68	48,9%

The numbers of building for which have information about technical measures implemented are 139. Each building can implement one or more measures. Envelope implementation is comprehensive both of walls, roofs, basements and windows surfaces. Partners gave information on U value and/or type of materials used for the construction. Also for windows information can be about U value of the glass surface and/or description of type of glass and frame used (double glass, triple glass, low-e coat glass, etc.). Some buildings are equipped with summer heat protection which basically means external shading devices, to protect the building from excessive summer heat gains.

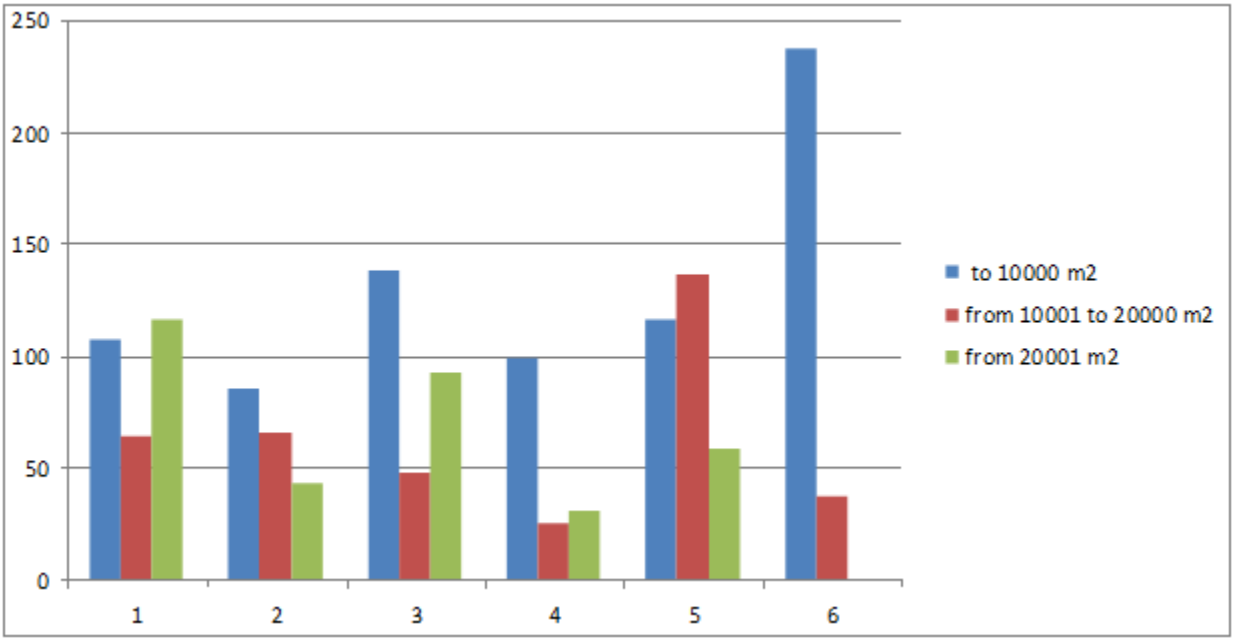
Control systems are used in heating system, cooling system and ventilation, but most of them are applied to the lighting system (daylight control, occupancy control, etc.).

The relation between number of measures, range of area and saving (in kWh/m2/year) is shown in the table below.

Table 20 Measure implemented and savings, in relation to the range of area

Nr. Of Measures Implemented	to 10.000 m2	from 10.001 to 20.000 m2	from 20.001 m2
1	106,8	64,2	116,0
2	85,1	65,5	42,9
3	138,2	48,0	92,6
4	99,1	25,0	31,0
5	115,9	136,4	58,6
6	237,4	37,2	0,0

Figure 18 Consumption (kwh/m2/year) for number of measures implemented and range of area.



From the table above we can say that the smaller is the building (in m^2), the bigger the savings are, independently from the number of measures implemented (a part in one case where the building range goes from 10.0001 to 20.000 m^2 and 5 measures are implemented; in this case the saving is bigger than in the smaller range of area). Secondly we can also say that the larger is the buildings, the major are the savings with less technical implementation.

4.1 Heating system

Within the general category of Heating, the followings principal systems were earmarked: district heating, heat pump, CHP (Combined heat and Power generation) and boilers (condensation, natural gas, biomass, oil).

Also other two measures have been identified in order to achieve energy saving in heating: control system and regulation system. Control systems are the following: motion presence detectors, week-end and night drawdown (temperature automatically decreases during the week-end or the night hours). Partners have indicated one or/and more of these measures.

District heating is the most used measures for efficient energy supply. 43 buildings are supplied by this type of technical measure.

District heating is a system for distributing heat generated in a centralized location. The heat is often obtained from a cogeneration plant burning fossil fuels. Also biomass, geothermal heating and central solar heating are used.

The use of heat pumps is the second measure more indicated. Heat pump is a device that diverts heat from one location (the source) at a lower temperature to another location (the sink, or heat sink) at a higher temperature using mechanical work or a high temperature heat source. A heat pump can be used to provide heating or cooling.

53 building are equipped with heat pump. In these types of pumps also geothermal ones are indicated (6 buildings) and ground water pump (1 building). A geothermal heat pump, ground source heat pump or ground heat pump is a central heating and/or cooling system that pumps heat to, or from, the ground. It uses the earth as a heat source (in the winter) or a heat sink (in the summer).

One Building is equipped with Borehole Thermal Energy Storage (BTES) which is an advanced closed-loop geothermal technology for seasonal storage and recovery of thermal energy in the earth.

Far behind the first two heating measures we find Cogeneration plants (CHP – Combined heat and power). Cogeneration is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat.

7 building are supplied by cogeneration. One with micro-cogeneration and one with tri-cogeneration plant (also called CCHP combined cooling, heat and power).

6 different types of boiler have been indicated among the heating's measures: condensation boiler (6), traditional boiler (1), natural gas boiler (4), wood chip/pellets condensing boiler (1), biomass boiler (3), rape seed oil boiler (1), and oil boiler (1).

Others measures indicated for energy saving in heating are heat exchangers and solar plant contribution for floor heating.

Table 21 Types of building's heating measures

BUILDING'S HEATING MEASURES		
Control systems		
Type	**Nr. of building**	**%**
Night drawdown	**17**	**12,2%**
Week- end drawdown	**3**	**2,1 %**
Motion presence detectors	**1**	**0,7%**
Regulation system		
Thermostatic valves	**6**	**4,3%**
Supply and or production systems		
District heating	**43**	**30,9%**
Heat pump	**53**	**38,1%**
Co-generation	**9**	**6,4%**
Boilers	**17**	**12,2%**
Borehole thermal energy storage	**1**	**0,7%**

4.2 Cooling System

The data on the type of cooling system adopted in the buildings is available for 66 over 183 (total number) of them. Different types of cooling system have been mentioned by the Partners. Starting from the envelope, permanents shading devices have been often installed on the windows in order to avoid unwanted solar gains (8 buildings).

Free-cooling have been adopted as an energy saving method to cool rooms and offices in 8 buildings. Free cooling is an economical method of using low external air temperatures to assist in chilling water, which can then be used for air conditioning systems. When the ambient air temperature drops to a set temperature, a modulating valve allows all or part of the chilled water to by-pass an existing chiller and run through the Free Cooling system, which uses less power and uses the lower ambient air temperature to cool the water in the system.

Only few traditional electrical powered compressors have been adopted. In all other cases efficient methods have been mentioned. Air-water heat pumps, installed for heating, have been also used, in warmer season, for cooling, when they have a reversible cycle. 14 building are equipped with this system. In heating and air conditioning (HVAC) applications, the term *heat pump* usually refers to easily reversible vapor-compression refrigeration devices that are optimized for high efficiency in both directions of thermal energy transfer. Also ground source heat pump has been used. These pumps have higher efficiencies than air-source heat pump.

District cooling is another method used for cooling strategy in 2010 GB programme. Working on broadly similar principles to district heating, district cooling delivers chilled water to buildings needing cooling. Chilled water is delivered via an underground insulated pipeline. Specially designed units in each building then use this water to lower the temperature of air passing through the building's air conditioning system. District cooling can be run on electricity or natural gas, and can use either regular water or seawater. District cooling systems can replace any type of air conditioning system, but primarily compete with air-cooled reciprocating chiller systems serving large buildings which consume large amounts of electricity. 7 building have adopted this system. Also cooling ceilings are mentioned as energy saving strategy. The cooling system consists in a radiant surface connected with a closed circuit containing chilled water. Considering the large surface available for heat exchange, the water temperature is only slightly lower than the room temperature; this small difference allows the use of either heat pump with very high coefficient of performance (COP), or alternative cooling sources.

Some buildings are equipped with a centralized mechanical cooling plant. A centralised cooling system has all the plants located in a single area, for example in a basement or roof-top plant room. One, or more, air-handling units condition the air which is then supplied by ductwork to the floors/spaces within the building. The air-handling units typically contain heating and cooling coils, a humidifier, filters, and fans to move the air. One or more chillers will typically be located nearby to provide chilled water for the cooling coils. Hot water for the heating coils is provided by a heat-raising system (such as gas boilers or heat pumps).

Table 22 Types of building's cooling measures

BUILDING'S COOLING MEASURES		
Control /Regulation systems		
Type	**Nr. Of building**	**%**
Presence sensors/ Temperature control	**6**	**4,3%**
Supply and or production systems		
Permanent shading devices	**8**	**5,7%**
Air-water heat pump	**14**	**10,0%**
Ground source heat pump	**3**	**2,1%**
Cooling ceiling	**7**	**5,0%**
Centralized mechanical system	**7**	**5,0%**
District cooling	**7**	**5,0%**
Free-cooling	**8**	**5,7%**
Traditional electrical powered compressors	**2**	**1,4%**
Others	**4**	**2,8%**

4.3 Ventilation

Most of the measures implemented in the ventilation system concerns heat recovery. Heat recovery ventilation, also known as HRV, mechanical ventilation heat recovery, or MVHR, is an energy recovery ventilation system using equipments known as a heat recovery ventilator, heat exchanger, air exchanger, or air-to-air heat exchanger which employs a counter-flow heat exchanger between the inbound and outbound air flow. HRV provides fresh air and improves climate control, while also saving energy by reducing heating (and cooling) requirements. Energy recovery includes any technique or method of minimizing the input of energy to an overall system by the exchange of energy from one sub-system of the overall system with another. The energy can be in any form in either subsystem, but most energy recovery systems exchange thermal energy in either sensible or latent form. An energy recovery system closes the "energy cycle", preventing the input power from being released back to nature and rather be used in other forms of desired work.

HRV can be a "stand-alone" devices that operate independently, or can be built-in, or added to existing HVAC systems. For a small building in which nearly every room has an exterior wall, then the HRV device can be small and provide ventilation for a single room. A larger building would require either many small units, or a large central unit. The only requirements for the building are an air supply, either directly from an exterior wall or ducted to one, and an energy supply for air circulation, such as wind energy or electricity for a fan. When used with 'central' HVAC systems, then the system would be of the 'forced-air' type. On 183 building 51 declared to have a heat recovery system (27,8%).

4.4 Lighting System

Lighting also represents one of the most easily achievable energy efficiency improvements with usually very short payback times. 62 of the Buildings in 2010 have included lighting upgrading among the efficiency measures. The measures mostly include use of more efficient lighting (compact fluorescent lamps, efficient fluorescent tubes, electronic ballast, LED lights). New lighting system in Partners buildings are also often managed through motion/occupancy detectors, daylight sensors or through localizing lighting. New lighting system in the Partner buildings are also often managed through motion/occupancy detectors as daylight detectors or occupancy sensors.

4.5 Envelope

The building envelope represents further significant potential for savings. For 32 buildings the U-value of the structure was available. From 2011 it is compulsory for all new buildings to specify it. The range in 2010 goes from 0,2 to 0,6 W/m^2K. It is likely to read this data as an implemented measure, because of its performance values.

Yet, the scope of improvement in the envelope system differs to large extent. It ranges from a total insulation of the building, including the whole building envelope (roof, façade, ground and windows), to only featuring some part of the envelope (such as better glazing or low U-value of the façade).

Different types of material and techniques have been used such as: mineral foam, mineral wool, polyurethane panels, curtain-type, ventilated glass façade, double shell façade and others. Windows are also a very important element in the envelope insulation. Both in new or refurbished buildings different type of windows have been installed, however the two most common types are double or triple glazing units. The U value indicated for the windows goes from 0,8 W/m^2K to 1,9 W/m^2K.

4.6 Renewable energies

31 buildings declared to have adopted one or more system supplied by renewable energy. In many cases one or more renewable energy are used in the same building.

The different types of system mentioned by the Partners are the following: solar thermal plant, photovoltaic system, geothermal plant, boiler supplied with biomass, co-generation plant supplied by bio gas. Renewable energy is used in new and refurbished building in almost the same percentage: 48% in new building, 45% in refurbished building. Two or more renewable sources are used in the 19% of building which declare to use renewable energy.

Table 23 Types of building's renewable energies

RENEWABLE ENERGIES- TECHNOLOGIES ADOPTED		
Type	**Nr. Of building**	**%**
Solar thermal plant	**8**	**4,3%**
Photovoltaic System	**13**	**9,3%**
Geothermal plant	**14**	**10,0%**
Biomass Boiler	**3**	**2,1%**
Bio-gas Cogeneration	**1**	**0,7%**

Below is given a short and synthetic description of the renewable sources used in the GB programme.

Solar thermal energy (**STE**) is a technology used to transform solar energy into thermal energy (heat). Thermal mass materials store solar energy during the day and release this energy during cooler periods. Common thermal mass materials include stone, concrete, and water. The proportion and placement of thermal mass should consider several factors such as climate, day lighting, and shading conditions. When properly incorporated, thermal mass can passively maintain comfortable temperatures while reducing energy consumption. Despite the fact that the effectiveness of solar systems largely depends on climatic conditions, and that normally are mostly used in southern countries, all the Partners buildings 2010 equipped with solar panels are located northern (Austria, Belgium, Germany and Sweden).

Photovoltaics (**PV**) is a method used to generate electrical power by converting solar radiation in to direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic systems are equipped with solar panels composed of a number of solar cells containing a photovoltaic material. Normally these plants are placed on the top of the building's roof. Mostly of the PV system are adopted by German Partners (53,8%) the other are located in Cyprus (1), Italy (1), Greece (3) and Belgium (1).

A **geothermal plant** uses its geothermal activity to generate power. This type of natural energy production is extremely environmentally friendly. To harness the energy, holes are drilled into the earth until a significant geothermal hot spot is found. When the heat source has been discovered, a pipe is attached deep down inside the hole which allows hot steam from deep within the ground to rise up to the surface. Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger-a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

A Biomass boiler and biomass co-generation plants use wood pellets, chip, logs and energy crops as fuel.

4.7 Control systems

The Partners buildings are often using building energy management and control systems. The system (often called Building Energy Management system BEMS) control and monitor all the buildings equipment such as HVAC and especially lighting system. The control system also helps in monitoring and evaluation of the energy consumption of the buildings, which provides a basis for energy savings. 52 buildings have one or more technical equipment provided with a control system (37,4%).

Conclusions

The report provides an evaluation of the European GreenBuilding Programme, a voluntary programme, which aims at improving the energy efficiency and expanding the integration of renewable energies in non-residential buildings in Europe. The analysis covers the year 2010 and compare the data of this year with the previous period time analyzed (2006-2009) in the report: “The European GreenBuilding Programme 2006-2009 – Evaluation. P. Bertoldi and M.Valentová”.

Until December 2010, total 283 partners have joined it with 469 partner Buildings. The total saving achieved by the Partners amounts to about 432 GWh/year. The result achieved in 2010 shows the positive growing trend of the Programme and of the energy saving achieved. In fact in 2010, 116 new Partners joined the Green Building programme with 183 buildings. 128 GWh have been saved in this year.

For 2010 a new category was introduced among New and Refurbished: Under Construction Buildings. In any case there is a very good balance between new buildings which joined the programme (48%) and refurbished ones (41%). Offices represent the biggest category for business type, in all three categories over mentioned.

Still the reported information varied greatly. The sets of data provided by the Partners ranged from a few numbers (% savings) and short description of measures to extensive reports. But is possible to say, comparing the previous period analyzed (2006-2009), that a harmonization between the reports is started. From 2011 the compilation of a excel spread sheet with all the most relevant information will be compulsory in order to join the programme.

The analysis offers some general conclusion:

Germany and Sweden are the leading countries of the GB Programme 2010 (for number of buildings and for absolute saving achieved); Cyprus and France are new countries that joined the GBP; Office category is the largest category of building joining the GB Pogramme; Private business category is the largest category of building joining the GB Pogramme (73,8%) . These data follows the similar trend of the previous period analyzed (2006-2009).

In 2010 the majority of the building is included in an area range between 1.001 m2 and 5.000 m2. In this range of area also the best average saving per kwh/year/m2 was achieved. The best absolute savings have been achieved in the category Office building. The best percentage savings have been achieved in Educational building and in refurbished buildings. The technical measures implemented are case specific, the majority of the building implemented 3 measures. These measures have been implemented in heating system, cooling system, lighting system,

control system, envelope insulation and adoption of renewable energies. Often, a combination of energy efficiency improvements and renewable energy sources was used.

Partners – alphabetical order

Partners and Partner buildings in 2010

1	AB Vassilopoulos S.A	1	Agios Dimitrios
2	Aberdeen Property Investors AB	2	Tobaksmonopolet
3	AFA Försäkringsaktiebolag	3	Gråmunkholmen 4
4	AHB Immobilien GmbH & Co KG	4	IAG Büro-Gewerbegebäude
5	Akademie Deutscher Genossenschaften ADG e. V	5	Schloss Montabaur Humbach
		6	Schloss Montabaur Tabor
6	Akademiska hus Norr	7	Naturvetarhuset LU1,LU3
7	Alecta pensionsförsäkring AB	8	Mölndal Krokslätt 20:4
8	Alfred Arnold Verladesysteme	9	Office and workshop Building Arnold Verladesysteme
9	ALLCON Investment Spólka zo.o. S.K.A	10	Allcon @ park 3
10	Amt Ortrand	11	NAW-Grundschulgwbäude
11	Architektrbüro Knetemann + Partner	12	Office Building Zeughaustrasse 70
12	Areim	13	Torkhuset 4
13	Ärzteversorgung Niedersachsen	14	Gutenberghof
14	Ayuntamiento de Ultzama	15	Ayuntamento,Serviscios Sociales, Centro Civico, centro de salud, Fronton Municipal, Polideportivo, Piscinas Municipales y Colegio Comarcal
15	Bayer Real Estate GmbH	16	Kindertagesstätte " Die Sprösslinge"
16	Beeline Logistikimmobilien GmbH	17	Logistikzentrum Beeline
17	Bezirksamt Treptow-Köpenick von Berlin	18	Grünauer Schule
18	Burco	19	The Platinum
19	C&SO Medical Properties LTD.	20	American Heart Institute
20	Capital Ship Management Corp.	21	Building in 3 Iassonos St., 185 37 Piraneus
21	Chalmersfastigheter AB	22	Vasa Hus 7
		23	Tessin N1
		24	Vasa Hus 15
		25	Najaden N5
22	City of Ludwigshafen	26	Wilhelm-Hack-Museum
23	City of Sonthofen	27	Gymnasium Sonthofen
24	CKG Betlehem	28	CKG Bethlem
25	Commerzbank AG	29	Silvertower
26	COMPACTHABIT	30	Residence Hall in Campus Montilivi II, Girona Univeristy.
27	Comune di Cologno Monzese	31	Polo Territoriale per la prima infanzia di Cologno Monzese

28 Crowne Plaza Copenhagen
29 Daimler AG
30 DC Commercial GmbH & Co. KG
31 DEKA Immobilien Invest GmbH
32 Det Notske Veritas Poland Real Estate Sp zoo
33 Diös Fastigheter AB
34 DVG mbH & Co Objeckt City Haus I KG
35 Echo Investment S.A.
36 EcoPuur cvba
37 Eklandia Fastighets AB
38 European Central Bank
39 Fastighets AB Brostaden
40 Fastighets AB Corallen
41 Fastighets AB LE Lundberg
42 Fastighets AB Norrporten
43 FastPartner
44 Flughafen Wien AG
45 Frankonia Eurobau Projektentwicklung GmbH & Co. KG
46 Galären I Luleå
47 GBG Manheimer Wohnungsbaugesellschaft
48 Gebrüder Plenter GbR
49 Gina Tricot
50 Grundschulverband Marktbreit
51 Halog Vermögensverwalfung Ruhr GmbH
52 Harder Rho GmbH
53 HDI Errichtung und Vermietung GmbH
54 Hofer KG
55 Hotel Wende GmbH & Co Kg
56 Kärnfastigheter
57 KF Fastingheter AB
32 Copenhagen Towers, building 409
33 B35 Office Bulding
34 B30 Produktionshalle
35 Friedrich strasse 19
36 GAP 15
37 Gerngross City Center Wien (Austria)
38 DNV Building
39 Mörviken 2:102
40 Tyr Valhall 10
41 Stigbygeln 2
42 Cityhaus 1
43 Park Postępu Building C
44 Park Postępu Building B
45 Park Postępu Building A
46 EcoPuur kantoren en magazijn
47 Tingstadsvassen 26:5
48 New ECB Premises
49 Svenska Bil (Smista Allé)
50 Ödman 15
51 Göteborg 9:31 Stampen
52 Kv Järnvägsstationen 2
53 Kv Krejaren 2
54 Office Park 2
55 Office Park 1
56 Friesenquartier Building FQ 22
57 Sign Hafenoffice
58 Ormen 1
59 Strandbad Manheim
60 Gewerbebau - Büro und Lagerstätten in Münster
61 Horngäddan 11
62 Grundschule marktbreit
63 HaLog Logistik Center
64 Siemens Logistikpark (Zum Roetepfuhl,14974 Ludwigsfelde
65 Haus der Ingenieure
66 Hofer Filiale St.Margarethen
67 Hotel Wende
68 Elinebergsskolan
69 Rösunda 5:2
70 Bäckebol Homecenter, Huvudbyggnaden

58	KiK Textilien und Non-Food GmbH	71	Rennerod
		72	Mainhardt
		73	Moordorf
		74	Freestand Neuried
		75	KiK Elsenfeld FM 01
		76	Berlin Marzahn
		77	KiK Weiler im Allgäu
		78	Zerbst
		79	KiK Obersontheim
		80	KiK Kochel am See
		81	Mutlangen
		82	KiK Altentreptow
		83	Neunburg
59	KK Beteilgungs GmbH & Co KG	84	Marburgerstrasse 13, Darnstadt
60	Klinikum Freising GmbH	85	BA3
		86	Canteen kitchen & office building
61	KölnBäder GmbH	87	Eis-und Schwimmstadion Lentstrasse
62	Komunaproject	88	Večnamenski Objeckt A in B
63	Konigstein im Taunus	89	Haus der Bagegnung
64	KOS Grundstücksges, Hamburg GmbH & Co.KG	90	Neubau Bürogeb, Grabenstrasse
65	KPMG Flintholm	91	Dirch Passers Al 2000 Frederiksberg
66	Kreis Offenbach	92	Schul-und Bildungszentrum
67	Landkreis Cham	93	R.Schumann-Gymnasium
		94	Landratsamt Cham (LRA)
		95	W.v. Siemens-Berufsschule
68	Landratsamt Main-Spessart	96	Realschule Gemünden
		97	Hallenbad Karlstadt
69	Landschaftsverband Rheinland (LVR)	98	LVR - Förderschule Louis-Braille
70	Landschaftverband Westfalen-Lippe	99	Erich-Kästner-Schule
		100	LWH Landesmuseum für Kunst und Kulturgeschichte Münster
		101	Turnhalle mit Offener Ganztagsschule
		102	Regenbogenshule
71	Lantmännen	103	HK Grodden, Hus B
72	Leifert Induction GmbH	104	Marie-Curie-Str.1 D-26129 Oldenburg
73	Lemminkäinen Talo Oy Pääkaupunkiseutu	105	Office Building Castro in Koy Polaris Business park
74	Markt Burgebrach	106	Volksschule Burgebrach
75	Marktgemeinde Langenzerdorf	107	Hauptschule Langenzerdorf
76	Marktgemeinde Rimpar	108	Matthias-Ehrenfried-Schule Rimpar
77	Matrix Immobilien AG	109	Einkaufs - und Bildungszentrum Waibling

78	MEAG Munich ERGO Asset Management GmbH	110	Maria-Josepha-Str. 13-15
79	Multi Park Mönchhof GmbH	111	Multi Park - Gebäude A & B
80	Münchener Rückversicherungsgesellschaft Aktiengesellschaft in Münchener MEAG	112	Sonnencarree in Munich
		113	Westegate Büro-und Geschäftsgebäude
81	Munnosal	114	Medical Practise
82	NCC Property Development AB	115	Airport Plaza III
		116	Maskrosen
83	NH Hotels	117	NH Bálago
		118	NH Bergamo
84	Nordstaden RE AB	119	Nordstaden 33:3
85	Object Office Center Handelskai Immobilienerrichtungs GmbH & Co KG	120	Rivergate
86	OPP Orstedskolen	121	Public School
87	Park-Office GdR IBA - Immotrend GmbH KSI GmbH	122	Bürogebäude Parkoffice - Citypark
88	Platzer Fastigheter	123	Streterdsvägen 82 - Bld. Nr. 2
		124	Streterdsvägen 80 - Bld. Nr. 10
		125	Streterdsvägen 84 - Bld. Nr. 11
		126	Streterdsvägen 96-100 - Bld. Nr. 12-14
		127	Streterdsvägen 90 - Bld. Nr. 8
		128	Streterdsvägen 86 - Bld. Nr. 3-4
		129	Balltorp 1:135
		130	Streterdsvägen 92 - Bld. Nr. 9
		131	Streterdsvägen 85 - Bld. Nr. 1
89	Public Power Corporation S.A	132	Pagrati
		133	Kallithea
90	R5R Grup Immobiliari	134	Cat Sant Joan Business Park - Building A
91	Regionservice	135	Pa-huset
		136	Psykiatri Geriatik
		137	Skånehuset
92	RheinEnergie AG	138	Neubau Hauptverwaltung Gebäude 13
		139	Neubau Hauptverwaltung Gebäude 15
		140	Neubau Hauptverwaltung Gebäude 11
		141	Neubau Hauptverwaltung Gebäude 14

		142	Neubau Hauptverwaltung Gebäude 12
93	Sant Llorenç Savall Town Council	143	El Patinet - Sant Llorenç savall's Kindergarden School
94	Schawb Versand GmbH	144	Logistikzentrum Schwab/ myToys Langenselbold
95	Siemens AG Österreich	145	Siemens City
96	Siemens AG Siemens Real Estate	146	Kita SieKids 81541
		147	SieKids München-Perlach
		148	KiTa Karlsruhe G.-Braun-Str. 16, 76187 Karlsruhe
		149	Kindernest im Röteheimpark
		150	Erlangen Gebäude 80
		151	Kita Kinderlaube
		152	Building W 1303 ibu Halle 39
97	Siemens Transmission & distribution	153	Building C3
98	Skanska Commercial Development Nordic	154	BCG48
99	Skanska Property Poland	155	Gunwaldzki center A,B and C
100	Solux GmbH	156	PHOW - Passive house Office and Workshop
101	Sparkase Herford	157	Sparkasse Herford
102	Sparkasse KolnBonn	158	Friedenplatz 1-3, 5311 Bonn
		159	Friednplatz 1-3, 53111 Bonn
103	Stadt Büdingen	160	Feuerwehrgerätehaus
104	Statens Fastighetsverk	161	Carlstens fastning
105	Stephan Terbrack GmbH	162	Neubau - Produktion
106	Svenska Kyrkan I Göteborg	163	Västra Frölundas
		164	Bergums Kyrka
		165	Billdals Kyrka
107	TechnologieCenter Eching GmbH	166	Handwerkerhoh Eching
108	TEDI GmbH & Co KG	167	TEDI Moordorf
		168	TEDI Mainhardt
		169	TEDI Berlin Marzahn FM 02
		170	TEDI Bad Abbach
		171	TEDI Elsenfeld
		172	TEDI Weiler im Allgäu
109	Tredingen Utveckling AB	173	Lindesbergs Arena
110	Uppsala kommun	174	Årsta 59:1
111	Vall De Nüria, FGC	175	Sant Josep Building
112	Vasakronan	176	Kv Nya Vattentornet 4
		177	Kv Telefonfabriken 1, Hus 05
		178	Päronet 17

113 Videum AB

114 Weisenburger Kita Halle GmbH

115 YIT Construction Ltd.

116 ZIAG Immobilien

179 Hus N

180 Kindertagesstatte Taubenhaus

181 Kindertagesstatte Reggio Kleiner Raabe

182 AVIA LINE II - OFFICE BUILDING

183 Stadtfenster Dortmund

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Abstract : GreenBuilding is one of the most important campaigns for the promotion of energy efficiency in non-residential buildings in Europe. The GreenBuilding Programme is a European Commission voluntary programme through which non-residential building owners and occupiers, being private or public organization, are aided in improving the energy efficiency and to introduce renewable energy sources into their building stock
The present report summarizes the result of the GreenBuilding Programme achieved in 2010, in terms of main energy efficiency measures in the building and related energy savings.

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